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Machine-tool Exhibition*

In the course of a year, Olympia presents many facets, ranging from Mills' circus to the "Ideal Home," yet never has it shown such a proud and well-dressed appearance as for the holding of the Machine-tool Exhibition. This is due to the policy of the Machine Tool Trades Association in prohibiting fancy stands and garish lighting, as they apparently believe, and we share the view, that the exhibits themselves should be of sufficient interest without being set off by limelight (or its modern equivalent) or Bond Street shop-fittings. From the galleries there is now a clear view of all the exhibits and not the collections of animated fun-fair booths usually erected to catch the eye from floor level. There is an economic aspect also, as, for many trade shows, the exhibitor has to pay more to the standfitter than the cost of a prefabricated house. This is a lesson that still needs learning and applying.

We estimate that no less than 4,000 tons of castings have been built into the machine-tools being shown. One cannot in this final stage assess their quality, for they all carry their "exhibition" finish. At the last exhibition, they carried "war finish" which in general was "near excellent." Most of the machines are painted in various shades of grey, and those carrying a bluish tint show up well, but for sheer beauty the one stand using blue alone is the best looking in the show. One machine-tool manufacturer expressed his disgust at the current practice of customers abetting their labourers in splashing green paint all over his beautifully-finished product. This manufacturer had interesting views on his own industry. His "tied" foundry was a "great convenience." It uses block cores for moulding and his main trouble is when they become misplaced, resulting in much extra work in the machine-shop. Moreover, this type of moulding involves much patternwork and those responsible for this department try to be too economical at the expense of the foundry. Machine-tool builders should be the first, not the last, to insist that their own departments are properly "tooled-up."

Before visiting the exhibition we were told to pay special attention to cutting-off wheels of the truly flexible type, but beyond experimental and very successful trials, the general supply seems as remote as ever, due to dollar shortage. However, the foundry executive visiting the exhibition can inspect as wide a range of grinding equipment, from portable tools to double-ended snagging machines, as he is likely to see during the next four years. There is a nice little model of a cupola and an outstanding collection of patternshop machine-tools. These exhibits alone warrant a visit by all progressive foundry owners.

* International Machine-tool Exhibition, Olympia, London, open until October 4.

Luncheon

GLENFIELD & KENNEDY'S CENTENARY

Last week, many prominent in foundry circles participated in the centenary celebrations of the well-known firm of engineers and founders, Glenfield & Kennedy, Limited, of Kilmarnock. The works had their origin in the formal association of the business of Mr. Thomas Kennedy—an inventor of a water-meter—and the place next door, the Glenfield Foundry. There was no such person as "Mr. Glenfield," for the word "Glen" in this part of Scotland means a daffodil; thus, what was more natural than to christen a foundry sited all amongst the flowers, "Glenfield"? To-day, the enterprise has so grown that it employs about 3,500 people. A few weeks ago, all the workmen received an extra week's pay to enable them celebrate the centenary in their own way. The executive staff are to have a week-end at Gleneagles as the guests of the firm. The main event, however, was the staging of a luncheon in the flower-bedecked Grand Hall at Kilmarnock for about 400 guests.

Mr. Hugh Cowan-Douglas, the chairman of the company, presided, and excellent speeches were delivered by the Earl of Home, P.C., Minister of State (Scottish Office), the Right Hon. Lord Bilsland, M.C., D.L., LL.D., and Sir Alexander L. McColl, a director of the company, who this week is to receive the freedom of Kilmarnock.

After luncheon, there was a visit to the works, and the changes carried out since the last war are widespread, specially noteworthy being the extent to which mechanization has been incorporated. Modern amenities have been included on a generous scale in the reorganization plan. The light foundry has been completely mechanized and all teething troubles overcome. One of the cupolas is basic lined, and, despite rather heavy patching costs, is giving good service. In the heavy foundry, a corps of young enthusiastic loam moulders has been created, so filling what is so often a gap in heavy castings production.

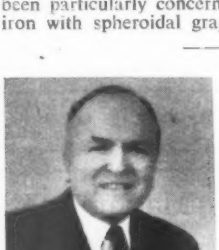
Film Review

A Case for Handling

A sound film giving an exposition of the science of materials handling, and proving the truth of the statement that "every time a material is handled something is added to its cost and nothing to its value," has been produced by the British Electrical Development Association. After describing the basic principles and showing how they can be applied to almost any industrial concern, one type of organization is examined in detail. A die-casting foundry is used, and it is seen first through the eyes of a materials-handling engineer, who is called in to advise on the problems of reorganization. He explains what he is attempting to do at a meeting in the works canteen, and by this means one sees not only the effect of his work on the efficiency of the factory, but also on the lives of individual employees. The film is intended for showing to operatives, foremen and staff up to the grade of works managers. It has a dual purpose—to show to workpeople that improved materials handling methods may give them the chance of a better sort of life, and to make managers aware of the science of materials-handling, and of how adoption of the principles can help to increase industrial efficiency. The film can be obtained on free loan from the British Electrical Development Association, 2, Savoy Hill, London, W.C.2, in 16 and 35 mm. sizes.

Conference Paper Authors

MR. I. C. H. HUGHES, B.Sc., A.I.M., is the Author of the Paper "Some Effects of Magnesium on the Formation of Graphite in a Solidifying Cast Iron," printed on page 349 of this issue. He was educated at Bembridge School, Isle of Wight, Portsmouth Municipal College, and Swansea University College, where he graduated with first class honours in Metallurgy in 1946, at the age of 21. In the same year, he joined the staff of the Mond Nickel Company, Limited, where he is now a research metallurgist at the Birmingham Laboratory. He has been engaged upon steel and cast iron research, and has been particularly concerned with investigations on cast iron with spheroidal graphite.



MR. J. J. DEWEZ, is the Author of the Belgian exchange Paper to the Institute of British Foundrymen Buxton Conference "Manufacture of High-quality Steel Castings at an Economic Price."* He was born at Court-Saint-Etienne, Belgium, in 1903, and graduated in 1926 from the University of Brussels as *Ingénieur Civil des Mines*. In 1927-28 he received a C.R.B. Fellowship to study electrometallurgy at the Carnegie Institute of Technology, Pittsburg, Pa. In the latter year, he returned to Belgium, and joined the Société Anonyme Usines Emile Henricot, Court-Saint-Etienne, Belgium, with which concern he now holds the position of works manager.

* Paper printed in the JOURNAL, July 10 and 17; the discussion is printed on page 365 of this issue.

Brassfoundry Productivity Conference Proceedings

It is expected that the collected proceedings of the Harrogate Brassfoundry Productivity Conference will go to press at the end of October. This worthwhile volume will contain all fourteen papers which were presented as well as discussions, including a report of the "Cost Clinic" and a summary of the conclusions. So that the printing number may be decided upon, brassfounders and all others who wish to receive copies, but have not already made reservations, are asked to express their full requirements immediately to the secretaries of the Association of Bronze and Brass Founders, Heathcote & Coleman, 25, Bennetts Hill, Birmingham 2. Each participant in the Conference will receive a copy of the "Proceedings" free of charge, extra copies are 7s. 6d. each.

FAIRBAIRN LAWSON COMBE BARBOUR, LIMITED—Mr. T. E. R. Harris has retired from the board owing to ill-health.

Some Effects of Magnesium on the Formation of Graphite in a Solidifying Cast Iron*

By I. C. H. Hughes, B.Sc., A.I.M.

A review is made of the existing hypotheses proposed to explain the mechanism of spheroidal-graphite formation, and their limitations are discussed. The detailed differences between the cooling curves of magnesium-free and magnesium-containing hypoeutectic cast irons have been determined experimentally, and samples of both types of iron, quenched from closely-spaced temperature intervals within and near the solidification range, have been examined microscopically. The presence of magnesium in inoculated irons depresses the eutectic temperature by 27 deg. C. under the cooling conditions studied, but solidification proceeds in both magnesium-free and magnesium-containing irons by an initial precipitation of primary austenite dendrites followed by the simultaneous growth of graphite and austenite at the eutectic temperature. In both magnesium-free and magnesium-containing irons graphite first appears in the liquid close to the austenite dendrites, but whereas flake graphite grows in contact with the liquid, each spheroidal-graphite particle develops, at an early stage, an austenite envelope, and its further growth involves diffusion of carbon from the liquid through the austenite. When a magnesium-containing iron is not inoculated, its eutectic temperature is depressed by a further 13 deg. C. and the last liquid to solidify transforms to an iron-carbide eutectic structure.

Introduction

Spheroidal-graphite cast iron has, in recent years, been the subject of a great deal of research. In particular, the mechanism by which spheroidal graphite may be formed has been discussed in a number of Papers, but, probably due to a lack of sufficient experimental data, there is as yet no accepted description of the mechanism of solidification of spheroidal-graphite cast iron which will explain all the observed features. In this Paper, a brief review is made of the main work and the hypotheses published to date, and results are reported of experimental work designed to provide information on the process of solidification of a cast iron in both the magnesium-containing and magnesium-free condition. The conclusions drawn from the experiments to be described relate only to the effect of magnesium. It is expected that the effects of cerium and other elements, which have the power to produce the spheroidal form of graphite, will show variations in detail which would have to be determined before the conclusions could be extended to cover spheroidal-graphite processes in general. On the other hand, since any solidification mechanism postulated must fully account for the effects of magnesium, it is considered pertinent to review briefly some of the characteristics of magnesium-containing irons from this standpoint.

When added to normally-grey cast iron, magnesium first combines with sulphur, the magnesium sulphide formed being removed by flotation, and, under normal conditions, until the sulphur has been reduced to around 0.025 per cent. very little magnesium can be retained in the iron. Furthermore, in irons of normal composition until about 0.025 per cent. of magnesium has been retained there are no obvious changes in the iron which cannot be attributed to a reduction in sulphur content. With a further increase in magnesium content, the graphite flakes become shortened and thickened, and the graphite finally assumes a fully-spheroidal form. At the same time, an increasing proportion of the carbon appears as iron carbide. This effect reaches its maximum at about the same stage as the formation of the fully-spheroidal-graphite structure, but is offset in normal section sizes by final inoculation with ferro-silicon or some other silicon-containing material.

The presence of magnesium in the molten iron renders its appearance " dull." According to Evans[1], however, the presence of magnesium is not associated with an appreciable decrease in fluidity. It is probable that an oxide film is present on the metal surface, which gives a false impression of low temperature and low fluidity. Solidification of a graphitic magnesium-containing iron is accompanied by shrinkage which is greater than that of an ordinary grey iron of the same equivalent carbon content, but less than that of a white iron of the same equivalent carbon content.

Suitable etching of a spheroidal-graphite cast iron reveals a cellular segregation pattern in which, as illustrated by Wittmoser[2], the spheroids are found within the cells, but not in their boundaries. Careful examination of hypoeutectic spheroidal-graphite cast irons under low magnification also reveals that spheroids are often orientated in straight lines which seem too obvious to be purely fortuitous. The microstructure of a hypoeutectic iron, showing graphite spheroids in lines, is illustrated in Fig. 1, the appearance of which suggests that the spheroids may be associated in some way with primary austenite dendrites. Segregation of graphite occurs in centrifugally-cast, hypereutectic magnesium-containing irons, but little, if any, occurs in hypoeutectic irons.

* Paper presented to the Buxton Conference of the Institute of British Foundrymen. The Author is attached to the Mond Nickel Company, Limited, Birmingham.

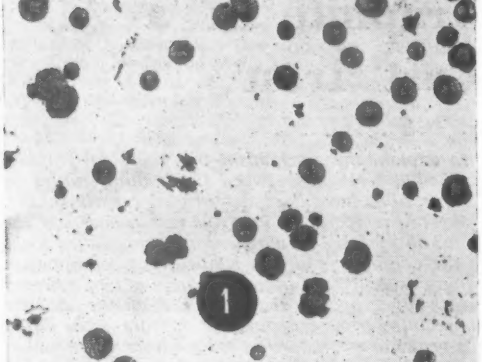


FIG. 1.—*Hypoeutectic Spheriodal-graphite Cast Iron showing Spheriods tending to lie in Straight Lines. Unetched* ×100.

Similar segregation effects are also noticed in magnesium-free, flake-graphite irons, so that conventional ideas on the eutectic composition of cast irons appear to be valid for both magnesium-free and magnesium-containing irons. Some elements, when present in very small amounts, are able to hinder or prevent the formation of spheroidal graphite in magnesium-containing irons. Examples of such elements are lead and tin.

Most of the elements, other than cerium and magnesium, which have been claimed by various workers to produce spheroidal-graphite structures in cast iron, are similar in many of their physical and chemical properties either to cerium or to magnesium, or are to be found in the early "A" subgroups of the Periodic Table of elements. Examples of such elements include calcium and lithium. Three other elements, however, namely bismuth, tellurium and sulphur, have power to produce a small proportion of spheroidal-graphite particles in cast irons under certain conditions, and these must be considered in any complete theory of spheroidal-graphite formation. Furthermore, small spheroids of graphite may be obtained by quenching into water a magnesium-free, grey cast iron of fairly high graphitizing power from a temperature near to its liquidus. It has also been known for many years that spheroidal graphite may occur as a result of annealing some high-sulphur white irons. Occasional graphite spheroids are sometimes found associated with " inverse chill " in grey irons.

As far as the Author is aware, most, if not all, of the elements which have been shown to produce spheroidal graphite also have, to a greater or lesser extent, the effect of increasing the proportion of iron carbide in a cast iron. The increased tendency to form iron carbide seems to be a common feature of all the conditions under which spheroidal graphite is known to occur.

Review of Earlier Work

It is generally assumed that most flake-graphite cast irons may be considered to lie near to the eutectic composition in pseudo-binary eutectic iron/carbon systems having fixed silicon contents. Most engineering irons are hypoeutectic, and in these solidification proceeds by growth first of austenite dendrites, followed by the appearance of eutectic cells at the austenite/liquid interface, which grow finally to replace all the remaining liquid. In these eutectic cells, rosettes of normal graphite flakes grow with their leading edges in contact with the liquid. This mechanism has been well illustrated by Boyles[3], who concluded that the effect of inoculation with calcium silicide was largely one of increasing the number of eutectic cells.

A careful review of the literature has been conducted by Morrogh,[4] who has discussed in detail many of the possible mechanisms of formation and growth of spheroidal graphite.[4 5 6] Other workers have since offered further suggestions in this field. A very brief review is presented below of the main ideas which have been advanced. In general, the theories seek to account for either the mechanism by which the spheroidal, rather than the flake, form of graphite occurs, or else the effect of magnesium upon the solidification sequence in cast iron, with special reference to the origin and growth of graphite spheroids. It is possible that the two mechanisms are only indirectly related, and for the purpose of this review it has been found convenient to dissociate them to some extent. Although the experiments to be described deal only with the process of solidification, a brief review of the suggested spheroidizing mechanisms has been included for the sake of completeness.

Hypotheses Relating to the Spheroidal Form of Graphite

It has been proposed by De Sy[7] that graphite particles having different morphological forms require nuclei having different crystallographic structures. Thus, hexagonal compounds, such as silicon or silicates, nucleate flake-form graphite, while cubic compounds, such as magnesium carbide or magnesium silicide, nucleate spheroidal-form graphite. De Sy, Vennerholm, Bogart and Melmoth[8] and Habraken[9] have published high-magnification photomicrographs showing angular regions at the centres of spheroidal-graphite particles, which they claimed to be nuclei. Morrogh,[6] however, has pointed out that certain graphite planes, when polished, would appear to be different from the rest of a spheroid and would resemble a nucleus. According to the hypothesis relating graphite-particle shape with a particular kind of nucleus, the addition of magnesium, while destroying one kind of nucleus, promotes another. The function of final inoculation in this process is not defined, but it would appear to promote either type of nucleus, according to the magnesium content of the iron.

Adey[11] obtained graphite spheroids in a high-carbon iron which he strongly superheated. He later suggested[12] that superheating resulted in the de-

struction of all nuclei, with consequent supercooling of the melt. The spheroidal form of graphite, he argued, was produced as a result of pronounced supercooling. It has since been suggested by Morrogh that the effect which Adey ascribed to superheating was due to a reduction of magnesium from the magnesia crucible used. Morrogh[4] showed that in nickel/carbon and cobalt/carbon alloys, spheroidal graphite could be produced by undercooling of the eutectic reaction, and he had the requirement of supercooling in mind while developing the cerium process.

It is possible that the maximum rate of nucleation of the spheroidal-graphite eutectic reaction lies at a lower temperature than that of the flake-graphite eutectic reaction, and that the growth of the two forms could be represented on a time/temperature graph by two overlapping zones similar to those of pearlite and bainite in isothermal-reaction curves for steels. The addition of magnesium to the iron might suppress the (normally dominant) flake-graphite "nose" and allow spheroidal graphite to form at a lower temperature. The place of the alternative hypereutectic flake- or spheroidal-graphite form in this scheme is not apparent.

It has been suggested by the Author and his colleagues that complete deoxidation of cast iron, achieved when sufficient magnesium has been introduced, may be responsible for a change in growth characteristics of graphite particles. Sulphur, tellurium and bismuth, however, which are able to produce a few spheroids of graphite in cast irons, are not generally regarded as potent deoxidizers, so that this theory is, in its present state of development, far from complete.

Surface-layer Effects

Morrogh[5] has suggested that the element responsible for the spheroidal form of graphite may be present as an adsorbed or surface layer on the graphite particles. The consequent change in interfacial energy between the liquid (or austenite) and the graphite might account for the spheroidal formation of the graphite. Thall and Chalmers[13] have proposed a mechanism of the modification of aluminium/silicon alloys according to which the interfacial energy between the eutectic phases determines the forms which they assume. In their paper, they have suggested that spheroidal graphite in cast iron may occur by a similar mechanism, following a change in graphite/austenite interfacial energy. An increase in interfacial energy between molten iron and graphite, resulting from the addition of magnesium, has been demonstrated by Buttner, Taylor and Wulff,[14] who believe this to be responsible for the spheroidal form of graphite in a magnesium-containing iron. Iitaka[15] has also supported the idea of this influence of magnesium on interfacial energy. This hypothesis has interesting features, although it would be difficult to prove. The quantity of magnesium required to produce spheroidal graphite is a very small percentage of the iron, but represents about 2 per cent. of the weight of the graphite, which is by no means insignificant if the magnesium is concentrated in or near to the graphite particles.

Theories of agglomeration of graphite particles have been proposed by Bertschinger[16] and by Thyssen and Gaty.[17] The former suggested the "crumpling-up" of graphite flakes, after their formation, and the latter coalescence of small spheroids or flakes, involving a migration of graphite and ferrite. Neither of these theories appears to have received further attention.

Descriptive Hypotheses of the Solidification Process

The number of possible variations in the process of solidification of cast iron is large; some which have been suggested as being the most probable are briefly summarized in what follows:—

It has been suggested that the spheroidal form of graphite is precipitated from previously-formed austenite. On microscopic examination, spheroidal-graphite iron samples which have been quenched during their solidification have usually been found to contain graphite spheroids in positions either apparently within primary austenite dendrites or surrounded by austenite envelopes. Both De Sy[18] and Wittmoser[2] have supported the hypothesis that austenite forms first and then precipitates spheroidal-graphite particles, through a process involving greater-than-usual supersaturation of the austenite with respect to carbon. The cooling curves of Piwowarsky[19] show pronounced supercooling of the eutectic, which would seem to support this idea. Wittmoser has reasoned that spherical austenite crystals form first during the solidification of magnesium-containing cast irons and that graphite grows at the centre of each austenite crystal. Piwowarsky and Wittmoser have each constructed hypothetical modifications of the iron/carbon equilibrium diagram to illustrate possible supercooling conditions.

Morrogh[6] has suggested that a possible method of formation of spheroidal graphite may be by decomposition during cooling of a previously-formed carbide. This idea has been supported by Gillemot.[18] Support is also lent to the idea by the facts that for a given casting thickness magnesium-containing irons tend to contain higher percentages of iron carbide than magnesium-free irons of the same basic composition, and that they exhibit solidification shrinkage approaching that of white irons.

It is possible that spheroidal-graphite particles originating during the eutectic reaction form in the liquid. Morrogh[6] has shown that segregation of graphite spheroids occurs in hypereutectic cerium-containing irons and has suggested, upon the basis of this and of the results of quenching experiments, that in cerium-containing irons graphite spheroids can originate in the liquid. The observed segregation of graphite in magnesium-containing hypereutectic irons suggests that, in these irons also, graphite spheroids can originate in the liquid. The view that in hypoeutectic magnesium-containing irons the spheroids originate in the liquid is supported by Buttner, Taylor and Wulff[14] and by Dunphy and Pellini.[20] It is reasonable to assume that graphite spheroids originating in the liquid will, in the eutectic range, become surrounded by solid austenite and that growth will

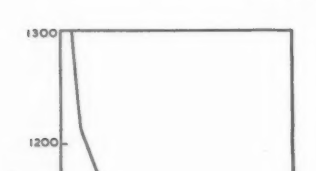


FIG. 2.—*Cooling Curve of the Centre of a 2-in. diameter Sand-cast Bar.*

thereafter continue in the solid state by diffusion of carbon from the liquid to the spheroids. Dunphy and Pellini believe that the last liquid solidifies as iron-carbide eutectic and that this decomposes during cooling, forming austenite and graphite which is deposited by diffusion upon the already-existing spheroids.

Some combination of mechanisms is possible, for it is conceivable that graphite nuclei precipitated in the liquid nucleate the austenite primary crystals and then also give rise to the graphite spheroids at the eutectic, so that growth proceeds by a diffusion mechanism in the manner suggested by Wittmoser.[2]

None of these hypotheses is complete, and a study of them makes it clear that it is not possible to describe reliably the mechanism of formation of spheroidal graphite in the absence of additional data on the solidification process.

The work of Dunphy and Pellini[20] was reported before the work described in the present Paper was completed. These Authors determined the cooling curves of irons cast as 2 in. dia. bars in sand, and found that the curves of magnesium-containing irons had lower arrest temperatures than those of magnesium-free irons of similar composition. They did not inoculate their magnesium-containing irons but used a silicon-containing magnesium addition alloy. From the examination of quenched samples, they concluded that solidification of a magnesium-containing hypoeutectic cast iron proceeded by the initial precipitation of austenite, followed by the growth of graphite spheroids with austenite envelopes during the eutectic reaction. The spheroids first appeared near to the austenite dendrites in carbon-rich regions in the liquid.

PROCEDURE AND RESULTS

The experiments described in what follows were designed to furnish data on the effect of magnesium, and also of inoculation, upon the solidification mechanism of cast irons of slightly hypoeutectic composition. The cooling curves of inoculated and non-inoculated magnesium-free and magnesium-containing irons were determined and samples quenched into water from selected stages of solidification were examined. In determining the effect of magnesium upon the cooling curves of the irons, it was felt essential to know at what temperature the iron-carbide eutectic reaction occurred under the same cooling conditions. A completely white structure was obtained in the iron by adding about 0.1 per cent. tellurium, and the cooling curve of this iron was determined. Apart from its small tellurium content, the iron had the same composition as the grey irons studied.

Materials Selected

The composition of the iron selected for study was nominally:—Total carbon, 3.4; silicon, 2.1; manganese, 0.4; sulphur, 0.02 per cent. max.; phosphorus, 0.03 per cent. max.; and nickel, 1.0 per cent. Melting was performed in a clay/plumbago crucible, in a gas-fired crucible furnace. The surface of each melt was kept covered by a layer of charcoal. Two base irons were used to make up the charges, these being a Swedish white iron and a refined white iron of the following percentage compositions:—

	Swedish iron.	Refined iron.
	Per cent.	Per cent.
Total carbon	3.8	3.6
Silicon	0.12	0.19
Manganese	0.05	0.24
Sulphur	0.02	0.02
Phosphorus	0.02	0.03

Adjustments of composition were made by crucible additions of manganese, ferro-silicon and nickel, due allowance being made for the change in composition produced by the late additions. Magnesium, when added, was introduced as 1.25 per cent. of a 15 per cent. magnesium/nickel alloy, and final inoculation, when required, was effected by the addition of 0.625 per cent. of 80 per cent. ferro-silicon. To produce a white iron, tellurium was added as 0.2 per cent. of a copper/tellurium alloy containing 40 per cent. tellurium. The final compositions of all the irons were intended to be similar except in their magnesium, sulphur and tellurium contents.

Experimental Methods

Before determining, for comparison, the cooling curves of the irons, consideration was given to the rate of cooling to be employed. It is not known if spheroidal graphite is an equilibrium phase and there appeared to be no particular merit in using extremely-slow cooling rates. To determine a convenient cooling rate, a number of preliminary experiments were performed. Cooling curves were determined on bars having diameters from 1 to 4.5 in. cast vertically in green-sand moulds. The length of each bar was at least 2½ times its diameter, and additionally a feeder-head was provided. The thermocouple used was of platinum/platinum-rhodium and its tip was located in a silica sheath at either the surface or centre of each bar, at the mid-length.

Melts were made of an iron of composition

similar to that employed for the main experiments. Each melt was withdrawn from the furnace when its temperature reached 1,450 dec. C. and was cooled to 1,350 deg. C. before pouring. While each melt was cooling in the crucible, the thermocouple in its sheath was preheated by immersion in the melt and was returned to the correct position in the bar mould just before pouring commenced. Temperatures were measured by means of a Cambridge potentiometer. Direct cooling curves were obtained, taking temperature readings at intervals of 10 or 15 secs. The potentiometer was read to 0.002 millivolt and temperatures were read from the calibration curve to the nearest degree C. It was found that the complete cooling curves at the centre of 1.5 in. and larger-diameter bars were easily obtained in this way, but that the early portions of the curves of smaller-diameter bars could not be determined accurately. Fig. 2 shows a cooling curve obtained for the centre of a 2 in. dia. sand-cast bar. In view of these results it was found to be experimentally convenient to employ a cooling rate slightly greater than that of a 2 in. dia. sand-cast bar.

Cooling was conducted in an apparatus shown diagrammatically in Fig. 3. A platinum-wound, vertical tube-furnace (A) is fixed, and serves as a temperature equalizer and preheater of the sample, which is contained in a small fireclay crucible (B) suspended by a platinum- or palladium-wire cradle (C) from a nickel-chromium alloy tube (D). This tube is counterbalanced by weights (K) and can move vertically up and down, carrying the sample with it. The internal diameter of the tube in ¼ in. and the thermocouple (E) can just slide freely up and down within it. The tube (D) passes through a second vertical tube-furnace (F) which is wound with Brightray wire and serves as a heated cooling chamber. This furnace is counterbalanced by weights (K) and can slide vertically up and down. The tops of both furnaces are closed by means of asbestos-board flaps and the bottom of furnace (A) is closed by a trap (G), which may be released in order to drop the sample into a water bath (H). The thermocouple tip is inserted into a silica sheath (I). Sheaths are produced by drawing down standard thermocouple sheaths 7 mm. in diameter, until they are only 3.5 mm. in diameter and less than 0.5 mm. thick at the closed end. The thermocouple (E) carries alumina insulators, the weight of which is taken by fused "beads" of platinum (or platinum/rhodium) at intervals along the wires. Furnace (F) is fitted with a fixed thermocouple (J).

Cooling-curve Determinations

For cooling-curve determinations the crucible (B) was of about 150 grams capacity. The procedure was as follows:—The thermocouple (E) was drawn up into the tube and an empty crucible was placed in the cradle. The precious metal of the cradle was previously coated heavily with alumina cement and alumina beads, to prevent attack by droplets of molten metal, but no other precautions were necessary. The furnace (A) was set at 1,400 deg. C. and the empty crucible was pre-heated in it for twenty minutes. The temperature of furnace (F) was held at 800 deg. C. Neither of these temperatures was found to be critical to within about ± 25 deg. C. The melts were all of 5 to 10 kg. (11 to 22 lb.). They were removed from the furnace at 1,400 to 1,450 deg. C. and skimmed clean. When magnesium treatment was required this was accomplished by additions of a nickel/magnesium alloy, and where inoculation was required an 80 per cent. silicon ferro-silicon addition was made. Each melt was finally stirred with an iron rod and skimmed very carefully. The temperature after skimming was about 1,350 deg. C.

With furnace (F) (Fig. 3) at the top of its travel, the crucible containing the sample (B) was raised out of the furnace (A). It was removed from the cradle with tongs and placed in an asbestos-lined shell, when a sample from the large melt was poured into it by means of a hand shank, after which the crucible (B) was returned to the furnace (A) and a layer of powdered charcoal was placed on top of the metal. After a little experience had been gained this operation was accomplished accurately in a few seconds. The sample weighed between 100 and 150 grams; it was held at a temperature of 1,350 to 1,400 deg. C. for about three minutes and during this time a thermocouple sheath was pre-heated beside the crucible and then inserted into it. The thermocouple was also preheated by lowering it slowly down the tube (D) into the sheath. When a steady temperature was recorded, the furnace (F) was lowered and the sample raised into it. A shutter

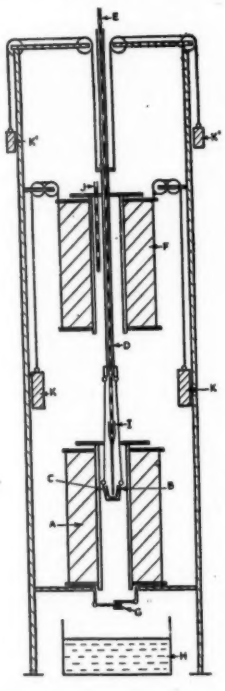


FIG. 3.—*Apparatus for Cooling-curve Determination. (Diagrammatic.)*

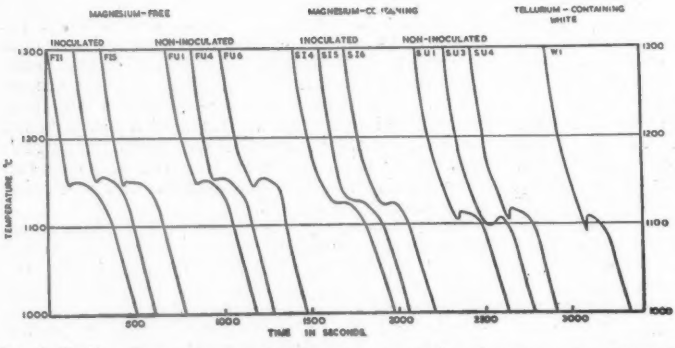


FIG. 4 (*Left*).—*Representative Cooling Curves of the Cast Irons Investigated.*

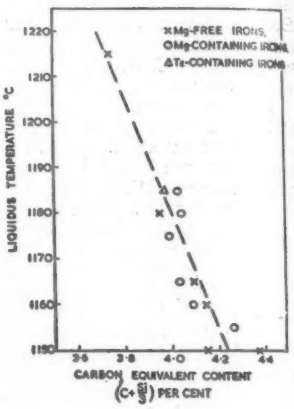


FIG. 5 (*Right*).—*Relation between Observed Liquidus Temperature and Equivalent Carbon Content.*

of asbestos board was used to insulate the two furnaces from one another. Furnace (F) was switched off after 30 secs.

The cooling curve was recorded down to 900 deg. C. as described earlier for sand-cast bars. The sample was then further allowed to cool through the eutectoid transformation before discontinuing the experiment. The sample was finally water-quenched and sectioned for microscopical examination and spectrographic analysis. A 2 in. dia. bar, 6 in. long, was also cast in green-sand from each melt and this was subjected to chemical and spectrographic analysis and to microscopical examination.

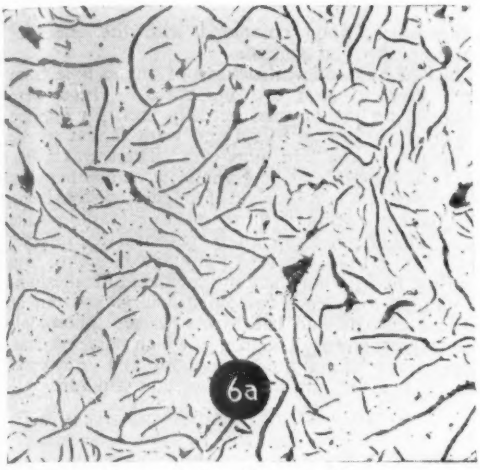
Reproducibility

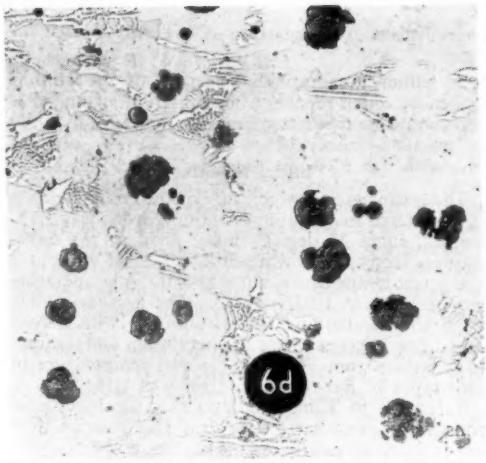
Except for the iron treated with tellurium, the cooling curves of the irons in each condition were determined at least four times and Fig. 4 shows typical curves obtained. For irons in the four conditions, magnesium-free non-inoculated and inoculated, and magnesium-treated non-inoculated and inoculated, three curves of each type are illustrated, to show the degree of agreement obtained. Although tellurium-containing irons were tested five times, only in one instance was a fully-white structure obtained. The cooling curve of the tellurium-treated iron is illustrated in Fig. 4 and is quite distinct from any other curve obtained both in the minimum temperature attained before recalescence, and in the degree of recalescence. In all the unsuccessful attempts to reproduce this curve, arrest temperatures were obtained between 1,130 and 1,150 deg. C., corresponding to flake-graphite structures produced in the samples. Details of the cooling curves, illustrated in Fig. 4, together with the compositions of the samples on which they were obtained, are presented in Table I. The mean arrest temperature and degrees of recalescence of the five types of iron are presented in Table II.

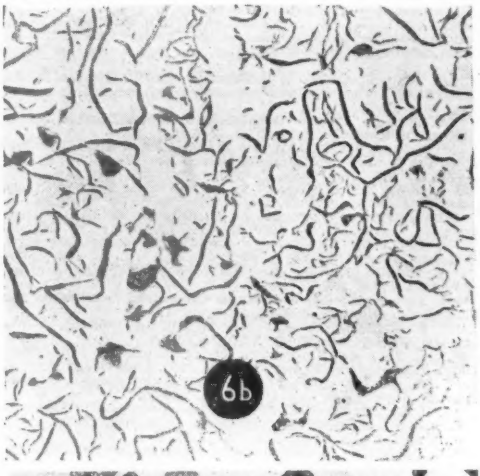
Under the melting conditions employed some variation in carbon and silicon contents occurred. This variation would not be expected to affect the eutectic temperatures significantly, but would be expected to affect the liquidus temperature. The magnesium contents of the magnesium-containing irons varied from 0.04 to 0.09 per cent. This is not considered to be important, since experience has shown that, for this particular iron, magnesium variations in this range have no observable effect

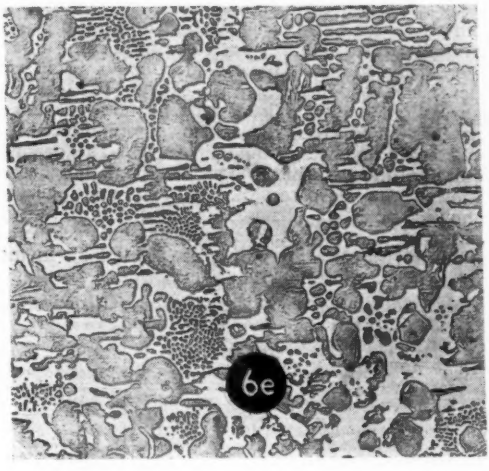
TABLE I.—*Details of Melts upon which the Cooling Curves Illustrated in Fig. 4 were Determined.*

Mark.	Chemical composition, per cent.							Equivalent carbon content, per cent.	Liquidus, deg. C.	Recalescence, deg. C.	Arrest Temp., deg. C.
	C	Si	Mn	P	Ni	Mg	Te				
FI.1 ..	3.57	2.4	0.43	.005	1.1	<.01	—	4.37	—	2	1,150
FI.2 ..	3.29	2.4	0.41	.014	0.98	<.01	—	4.09	1,165	5	1,155
FI.5 ..	3.45	2.15	0.47	.010	1.06	<.01	—	4.15	—	3	1,149
FU.1 ..	3.14	1.83	0.35	.010	0.78	<.01	—	3.74	1,215	4	1,150
FU.4 ..	3.44	2.1	0.52	.024	0.92	<.01	—	4.14	1,160	1	1,151
FU.6 ..	3.35	1.9	0.44	.008	0.62	<.01	—	3.95	1,180	10	1,152
SI.4 ..	3.34	2.0	0.38	.010	0.94	0.045	—	4.04	1,180	—	1,123
SI.5 ..	3.66	1.95	0.43	.006	0.92	0.070	—	4.26	1,155	—	1,126
SI.6 ..	3.39	1.84	0.43	.010	0.92	0.076	—	3.99	1,175	3	1,124
SU.1 ..	3.33	2.1	0.31	.006	0.92	0.041	—	4.03	1,185	9	1,113
SU.3 ..	3.39	2.0	0.42	.004	0.94	0.081	—	4.09	1,160	9	1,107
SU.4 ..	3.43	1.8	0.46	.015	0.97	0.076	—	4.03	1,165	13	1,116
W.1 ..	3.37	1.9	0.54	.007	0.86	<.01	Detected	3.97	1,185	18	1,107









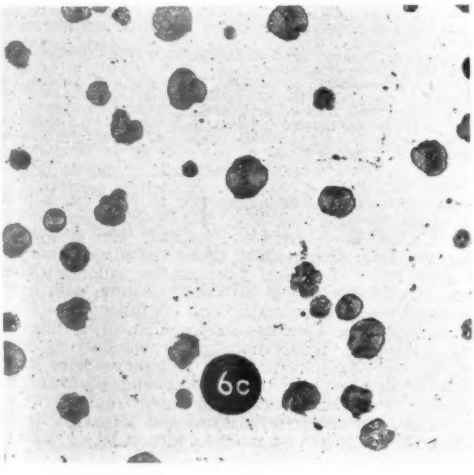


FIG. 6 (*a*) to (*e*).—*Representative Microstructures of the Types of Iron investigated.* ×100.

FIG. 6*a*.—*Inoculated Magnesium-free Iron F.I.*1. *Unetched.*

FIG. 6*b*.—*Uninoculated Magnesium-free Iron F.U.*:4. *Unetched.*

FIG. 6*c*.—*Inoculated Magnesium-containing Iron S.I.*6 *Unetched.*

FIG. 6*d*.—*Uninoculated Magnesium-containing Iron S.U.*1. *Lightly etched.*

FIG. 6*e*.—*Tellurium-containing White Iron W.*1. *Lightly etched.*

upon either the graphite structure or the chilling tendency, which reaches a maximum at around 0.04 per cent. and thereafter remains constant.

Initial Results

The mean arrest temperature of the cooling curves of inoculated magnesium-containing irons was 1,124 deg. C., some 27 deg. C. lower than of the flake-graphite irons. The white-iron solidified without a true arrest temperature, but a maximum temperature was obtained at 1,107 deg. C. The non-inoculated magnesium-containing irons solidified with arrests only a few degrees above the maximum temperature of the white-iron. The mean arrest temperature of both types of flake-graphite iron was 1,151 deg. C.

Reference to Table II shows that the inoculated irons were characterized by less recalescence than non-inoculated irons of the same graphite type. There was very little difference between the cooling curves of the non-inoculated and inoculated flake-graphite irons, which is not surprising, since, in an iron of the composition used, inoculation would not be expected to have a great effect. The cooling curves of the white iron and the non-inoculated magnesium-containing irons showed pronounced recalescence and were similar in form. The cooling curves of the inoculated magnesium-containing irons showed the least recalescence and some curves showed none at all, but in others it certainly occurred, though during recalescence the temperature rise was less rapid in these irons than in the other irons studied.

TABLE II.—*Mean Results Obtained from Cooling Curves of the Cast Irons Investigated.*

Iron.	Arrest temperature.	Recalescence.
	Deg. C.	Deg. C.
Magnesium-free, inoculated ..	1,151	3
Magnesium-free, non-inoculated	1,151	7
Magnesium-containing, inoculated	1,124	2
Magnesium-containing, non-inoculated	1,111	11
White (one result only)	1,107	18

The liquidus temperatures varied widely in these curves, and in two curves the liquidus appeared to be absent, or coincident with the eutectic arrest. In Fig. 5 the liquidus temperatures have been plotted against the carbon-equivalent contents of the melts, using the abbreviated formula C.E. = $(C + \frac{Si}{3})$ per cent. From this figure, the dependence of liquidus temperature on equivalent carbon content is obvious, small changes in the C.E. value having a profound effect on liquidus temperatures, and in all work on samples quenched during solidification only these having liquidus temperatures between 1,160 and 1,200 deg. C. were used in compiling results. In view of the way in which all the results fell on or near to the curve in Fig. 5, it is inferred that magnesium has no significant effect upon the liquidus temperature, when compared with the effect of equivalent carbon content.

In Fig. 6 the microstructures of one sample from each type of iron are illustrated. These were obtained on the samples actually used for cooling curves illustrated in Fig. 4 and were similar to the structures of the 2 in. bars cast. There was a distinct difference in flake-graphite structure between inoculated and non-inoculated magnesium-free irons, the former having a more-uniform graphite-flake size. The magnesium-containing inoculated samples each had a fully spheroidal-graphite structure in a pearlitic matrix, but the non-inoculated magnesium-containing irons each contained a large amount of eutectic carbide and had a less-perfect spheroidal-graphite structure. The iron to which tellurium had been added was white throughout and showed a normal type of iron-carbide eutectic structure.

(To be continued)

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In connection with a proposal to establish a technical college at Mosul, Iraq, Mr. Paul McCleester, c/o the United States Embassy, Bagdad, who is working for the Iraqi Government under the auspices of the United States Technical Co-operation Administration, has asked for a supply of trade literature, with specifications, and price quotations on the following:—Complete foundry and welding shop equipment; woodworking machinery, refrigeration and air-conditioning, electricity, farm equipment repair and automobile repair shop equipment; and hand tools and oil-fired unit heaters. Full details can be obtained from the Board of Trade, Commercial Relations and Exports Department, Horse Guards Avenue, London, S.W.1.

Sampling for Analysis

The difficulty of sampling large iron castings for analysis has recently been the subject of investigation by the British Iron and Steel Research Association's pig-iron, carbon and low-alloy steels analysis sub-committee. Results have been published in considerable detail in the Journal *of the Iron and Steel Institute. The intention of the present article is to discuss these results in a rather more general way. It should be made clear that there appears to be no means of counteracting the well-known difficulty of obtaining analytical samples representative of a casting as a whole. In an ingot mould, for example, a random distribution of coarse graphite flakes is almost inevitable, and when any analyses for carbon are quoted the actual position of the sampling point should be stated. It seems possible, however, to overcome the further difficulty of reproducibly determining combined carbon in graphitic iron, and the sub-committee have devised a method of sampling which appears to be superior to any previously examined.*

The various methods of sampling used hitherto involve milling or drilling the sample, and suffer from the disadvantage that there is a danger of losing graphite through the fine dust which such methods generate. Moreover, to make the sample actually withdrawn by the chemist for analysis sufficiently representative of the sample taken from the casting it must contain the correct proportion of the various particle sizes. This necessitates either (1) sieving the bulk into fractions, weighing them and taking the correct proportion of each to make up the analytical sample; or (2) reducing the whole sample to as uniform a size as possible by crushing; or (3) taking a small sample, by means of a fine drill operating at a very slow speed, and using the whole of it for one determination. A further alternative is to avoid milling or drilling altogether by (4) taking the whole of a selected solid test-piece as an analytical sample. It was decided to examine the reproducibility of samples taken in all four ways.

It has always been difficult to distinguish between errors arising from the shortcomings of the sampling techniques and those arising from faulty or inaccurate chemical techniques. Before the work on sampling could proceed it was therefore necessary to establish a satisfactory standard chemical method of analysis. Trials showed that derivation of the combined carbon by difference (following separate determinations of total and graphitic iron) was better than the direct procedures investigated and this technique was adopted in the examination of sampling methods. Results indicated that solid pieces provided the highest and most consistent figures for total and graphitic carbon. Drilling with small-diameter drills ($\frac{1}{8}$ in.) at slow speeds (20 r.p.m.) and using all the material from each hole as an analytical sample gave results very nearly as good, while drilling at a high speed was entirely unsatisfactory even when the proportionate weighing principle was used.

Cast Pin Samples

The two most promising methods of sampling were then checked against $\frac{1}{8}$ in. dia. samples cast in a special pin mould. At the time of sampling the molten iron, a special cup-shaped mould having $\frac{1}{8}$ in. dia. holes in the base was filled with metal. When cold, the small pins were broken off and pieces of suitable length used for carbon determinations. Some comparative results are shown in Table I. Here again, results from the drilled samples, though they tended to be a little lower than the pin samples, were nearly as accurate, and justified further extensive trials. Results of these trials are shown in Table II. For these, suitable sample blocks were taken from a used ingot mould of 4 in. wall thickness. The mould was broken and a piece from just above the centre-line was selected. The outside and inside faces were machined off and, from the remainder, 12 adjacent test-pieces were cut, each measuring $1\frac{1}{4}$ in. by $1\frac{1}{4}$ in. by $1\frac{1}{8}$ in. Two $\frac{3}{4}$ in. dia. flat-bottomed holes were drilled in each test-block to provide recesses for drilling $\frac{1}{8}$ in. dia. sample holes. For solid samples, the total and graphitic carbons were grouped together and averaged to give an overall combined-carbon figure by difference. A similar procedure was followed with drilling, the results on the two $\frac{3}{4}$ in. holes being kept separate. The table shows that both total and graphitic-carbon results obtained from solid test-pieces were about 0.1 per cent. higher than those from carefully prepared drillings. This may be partly due to the loss of a small amount of graphite which cannot be removed from the $\frac{1}{8}$ in. dia. hole and from the twist of the drill. Preparing samples with a $\frac{1}{8}$ in. dia. drill at low speeds is a slow operation and as the hole becomes deeper the grinding action between the drill and the iron particles at the bottom of the hole increases.

Solid Samples Preferred

It therefore appears that for accurate and reproducible carbon figures with high-carbon irons it is necessary to use solid samples. The preparation of such samples with a hacksaw is obviously inconvenient in many cases. The sub-committee therefore sought a mechanical means of sample preparation and it was found that the hollow mills described in B.S. 122—1938 (the British Standard Specification

TABLE I.—*Comparison of Percentage Total-carbon Results obtained from Several Sampling Techniques.*

	Sampling technique.		
	$\frac{1}{8}$ in. dia. pins from a pin mould.	Sawn samples, $\frac{1}{8}$ in. by $\frac{1}{8}$ in. by $\frac{1}{8}$ in.	Drillings, $\frac{1}{8}$ in. dia. drill at 20 r.p.m.
Hematite ..	4.57, 4.57	4.52, 4.50	4.44, 4.45, 4.48
Hematite ..	4.42, 4.43	4.36, 4.38	4.36, 4.35
Ingot mould	3.97, 3.97	3.95	

TABLE II.—*Ingot-mould Sample MGS/142, Carbon Results from Solid Pieces and from Drillings.*

Operator	Solid samples.			Drillings (½ in. dia. drill).			Drilling speed, r.p.m.
	Total C, per cent.	Graphitic C, per cent.	Average Combined C, (by difference).	Total C, per cent.	Graphitic C, per cent.	Average combined C, (by difference).	
A	3.98	3.35		3.85	3.16		15
	3.95	3.39		3.89	3.19		
	3.93	3.33			3.11		
	3.90	3.30	0.60		3.16	0.71	
				3.82	3.27		
				3.86	3.29		
					3.22		
					3.22	0.59	
B				3.86	3.35		25
				3.85	3.30		
					3.35		
					3.30	0.53	
				3.85	3.38		
				3.87	3.37		
					3.35		
					3.32	0.51	
C	4.03	3.43		3.96	3.21		23
	4.06	3.33		3.93	3.24		
	4.06	3.37	0.66	3.98	3.25	0.73	
				3.98	3.21		
				3.99	3.18		
				3.96	3.26	0.73	
D	3.96	3.33					
	3.98	3.35					
	3.98	3.32					
	3.92	3.33					
	3.94						
	3.98		0.63				
E	3.82	3.30		3.82	3.16		25
	3.89	3.33		3.82	3.20		
	3.83	3.28			3.26		
	3.89	3.29	0.56		3.20	0.62	
				3.80	3.18		
				3.80	3.18		
				3.78	3.18		
					3.26		
					3.17	0.59	
F	4.01	3.38		3.90	3.28		25
	4.09	3.44		3.90	3.30		
	4.03	3.33		3.93	3.28		
	4.04	3.32		3.88	3.28	0.62	
	4.03	3.37		3.89	3.26		
	4.03	3.41		3.90	3.27		
	4.02	3.41	0.65	3.91	3.28		
				3.90	3.25	0.63	
G	3.98	3.28		3.92	3.33		20
	3.96	3.32		3.92	3.29		
	3.97	3.27		3.97			
	3.92	3.36		3.93		0.62	
	3.99			3.93	3.19		
	3.98			3.88	3.23		
				3.86			
				3.92		0.69	
H	4.02	3.58		3.98	3.29		25
	4.14	3.49	0.55	3.97	3.36		
				3.90	3.33		
				3.96	3.31	0.63	
				3.92	3.14		
				3.90	3.10		
				3.94	3.17		
					3.29	0.74	
Averages..	3.98	3.36	0.62	3.90	3.25	0.65	

for milling cutters and reamers), pages 20 and 42, provided a simple method of obtaining test-pieces of suitable size and weight. These mills, which are made in several sizes, can be fitted with an attachment, *e.g.*, a taper shank, and used with an ordinary drilling machine to give cylindrical samples of various diameters. For example, the ½ in. dia. mill drills a hole ⅝ in. dia. leaving a pencil-shaped piece of metal ⅛ in. dia. standing in the centre of the hole. This pin can be broken out and, as a piece ¾ in. to 1 in. long weighs about 1 gram., it is of ideal size and shape for direct combustion in oxygen. As the pins also dissolve readily in dilute nitric acid they may be used with equal success in the determination of graphitic carbon. Shorter specimens, of $\frac{3}{16}$ in. dia. have also been employed; for total carbon determinations, these require a longer pre-heating time than those of ⅛ in. dia.

Carbon determinations were made on a variety of high-carbon pig- and cast-irons, comparing the results obtained from hollow-mill samples with those from hand-sawn solid pieces and from drillings produced with a ⅛ in. drill operating at

(*Continued on page* 364)

Gas Removal from Molten Aluminium Alloys*

Discussion of Mr. A. W. Brace's Paper

Chlorine Compounds

MR. A. LOGAN said the Author painted a somewhat gloomy picture regarding the matter of gas and unsoundness due to the presence of gas. Several statements were made in the early paragraphs which were surely not a correct interpretation of the true state of affairs existing at the present time; for instance, it was stated that "Simple rule of thumb methods by which a standard amount of the compound is added to metal cannot be relied upon to yield consistent results." It was well known that the passing of chlorine through molten aluminium was effective as a gas-remover. The well-known disadvantages attendant upon the use of chlorine included unpleasantness and danger to personnel, and the grain coarsening of the alloy on which the gas was used. These disadvantages had been completely overcome by the use of chlorinated compound, which released chlorine on being submerged in the metal, and which could also be combined with grain-refining compounds. Such compounds were readily available commercially, and could be effectively applied by any aluminium foundry. Their usefulness could be conclusively demonstrated both as regards gas-removal and reduction of grain size. It was difficult to see, therefore, on what grounds the statement was made that such compounds could not be relied upon to yield consistent results. The proof of gas removal or otherwise could be shown by the application of the vacuum-solidification test, which, incidentally, the Author had not mentioned.

Gas content had been assessed by the Author by means of micro-examination, but apparently he did not intend his sweeping condemnation of degassing compounds to be taken too seriously, for later, where he had metal of increasing gas content, he stated that "On applying a gas-removing compound containing chlorine and boron, the excess gas was fairly quickly removed." In actual fact he also found that it was so effective that using too much, or applying too long, produced porosity of another sort—in other words, porosity due to shrinkage. This was very interesting, for many observers had gradually come to the conclusion based on practical experience, that complete removal of gas might not be ideal. Too much gas might result in pinhole porosity, but completely gas-free metal might result in shrinkage unsoundness, and it was difficult to differentiate except by careful micro-examination—consequently there was a good deal of confusion in foundries between the two effects. It would appear that for any one particular casting there probably was a suitable gas-content which would give maximum soundness. The difficulty was that this suitable gas-content might vary from casting to casting, and under such circumstances, how was a foundry to know how it could obtain any particular casting sound. There appeared to be no ready-made answer to this problem. What he (Mr. Logan) suggested we needed was a good deal more fundamental information on this practical problem of gas-content in relation to varying section and mass. Where a certain casting was produced in large numbers, the problem could be tackled in a practical way by checking the gas-content quantitatively by vacuum solidification; then by varying it and checking the result on the casting to get an indication of the gas-content which would give soundness in that case.

It might, for instance, be necessary completely to remove all gas, then deliberately add the quantity found by experience necessary to give soundness. The Author appeared to have done this in another and roundabout way, which might not be entirely satisfactory because it was not sufficiently positive.

MR. FRANK HUDSON said every non-ferrous foundryman was interested in being able to control the amount of gas present in the metal. In the copper-base side of the industry they also needed a quick and positive test for indicating melt quality. He had written to the Technical Council of the Institute suggesting that a sub-committee should be formed to investigate the development of a suitable control test for copper-base alloys. In view of Mr. Brace's Paper it might be advisable to widen the above terms of reference and develop a test for assessing the melt quality of non-ferrous alloys in general. It would be valuable to have the views, and the support, of the members present regarding this proposal.

He had one question to ask Mr. Brace. In the Paper, a control test (Fig. 8) is outlined for assessing the melt quality of aluminium-base alloys. In this test, a fracture-test is first taken, followed by preparation of a specimen for examination under the microscope. Did one learn anything from the appearance of the fracture?

MR. BRACE said that, with experience, information could be obtained from the fracture on the general quality of the metal, but it was not very helpful on gas content, except when it had reached a rather high level. Some foundries cast a round block of metal and observed the surface during solidification. It was not a really satisfactory method for castings of thick section required to resist high hydraulic pressures.

* Paper presented at the Annual Conference of the Institute of British Foundrymen at Buxton, and printed in the JOURNAL, July 3, 1952; Mr. J. Bell, junior vice-president of the Institute, was in the chair.

Gas Removal from Aluminium Alloys—Discussion

Reduced-pressure Test

MR. R. JAY (British Non-Ferrous Metals Association) expressed disappointment that the Paper had not made reference to the reduced-pressure test for detecting gas in molten aluminium alloys. Many present were no doubt aware that this was a simple test in which a small sample from the melt was allowed to solidify under reduced pressure, so that any gas present could be readily evolved and observed. Alternatively, the sample could be sectioned after solidification to reveal enlarged gas holes. The test was used extensively in the British Non-Ferrous Metal Research Association's foundry and also in the foundries of several members' firms.

It could be safety assumed in most cases that if gas was not detected in this test, little gas-porosity would result in the casting unless gas was picked up between the melting furnace and the mould. This, he thought, was an extremely important point, as, in a number of cases of gas-porosity investigated by the Association, it had been shown that the molten metal itself had often been adequately degassed but porous castings had resulted because gas had been picked up from insufficiently dried ladles, launders, etc.

With practice the test could also be used as an approximate quantative measure of the amount of gas present, and hence provide a means of controlling the gas content where a trace of gas was known to be advantageous

Referring to the grain coarsening noted by the Author after the use of chlorine, Mr. Jay asked whether it was quite certain that the grain-coarsening was in fact due to the degassing agent employed. He and his colleagues had noted grain-coarsening when degassing with nitrogen for a prolonged period but never with chlorine or hexachlorethane. In one case the metal was raised to about 900 deg. C. before removing to the degassing site and he wondered whether grain coarsening was in fact due to overheating rather than degassing. The loss of titanium noted might not be significant, since Cibula had shown that the amount of titanium present as nuclei was a very small proportion of the total titanium content. Chlorine of course has an exothermic reaction with molten aluminium and the melt temperature hence might not have fallen considerably during degassing.

The Author's recommended control system for use in a foundry was evidently effective; an alternative method would be to degas each melt to the required degree by checking with the reduced-pressure test already mentioned. This method of control was rapid and was a check on every melt as distinct from an occasional test. It was clear that the gas content of a melt was not always initially the same and that every casting did not require the same amount of gassing to disperse shrinkage and it thus seemed reasonable to assess the gas content of every melt where possible.

In conclusion Mr. Jay suggested that a possible way of overcoming the difficulty of assessing the optimum gas-content of a casting might be for aluminium founders to co-operate in the examination of a number of commercial castings cast from metal with varying gas-contents in an effort to assess the maximum and minimum contents permissible. It might be found that a fairly wide range of gas-content could be tolerated and the problem would then be to find a method of maintaining a controlled gas-content in the melt. One possible way of doing this might be to pass a controlled mixture of hydrogen and nitrogen into the melt.

In reply to Mr. Jay, MR. BRACE agreed that the reduced-pressure test was very valuable, but its adoption involved consideration of the cost of the apparatus and the ease of interpretation of the results obtained. Some founders thought it was easier to check the metal by microscopic examination rather than to use the reduced-pressure test. In fact, the choice of a suitable method of control largely depended on the equipment and staff available, as well as the foundry's requirements. In normal production, a once-daily check was usually adequate. With regard to the grain-coarsening reported in the chlorine equipment, this was due in part to the high temperature reached by the melt.

Changed Distribution

MR. D. C. G. LEES said the most interesting part of Mr. Brace's Paper to him was where, towards the end, he stated that in his foundry the application of more than an optimum quantity of chlorine to melts (presumably in LM4, LM7 and other leading alloys) resulted in the appearance of shrinkage cavities in the castings. Was it contended that the castings to which more than the correct chlorine had been applied were of lower *density* than the others, or was it simply that the distribution of the porosity was changed so that in some sections there was enough concentrated porosity to show up (say) in a radiograph or a sawn section?

His own guess was that it was the *distribution* which was changed when too much chlorine was passed and the metal thus became too low in gas. There had been occasional suggestions that a completely degassed melt gave porous castings because of an exaggerated degree of shrinkage porosity; but he preferred to believe that the matter was one of *distribution*. As supporting examples, he quoted that Baker, Child and Glaisher working on bronzes found that the amount and distribution of porosity in a simple 5-in. dia. disc, centrally run with a boss on both sides of the flange, were much affected by gas. In a phosphor-bronze containing 0.7 per cent. phosphorus, which was prone to the metal/mould reaction, the porosity was fairly evenly distributed so that the boss was not excessively porous and the castings had a high quality as regards pressure-tightness. If the sand was baked so that the metal/mould reaction was much reduced in severity, the casting as a whole became slightly sounder, but the porosity was concentrated to a much greater extent than before towards the centre. Thus there was much leakage under pressure at the fillet between boss and flange. In the same sort of way, Mr. Lees had made castings (as shown in Fig. x) in LM10 (D.T.D.300, aluminium/10 per cent. magnesium) and made strip tensile-pieces from the positions shown. If the metal/

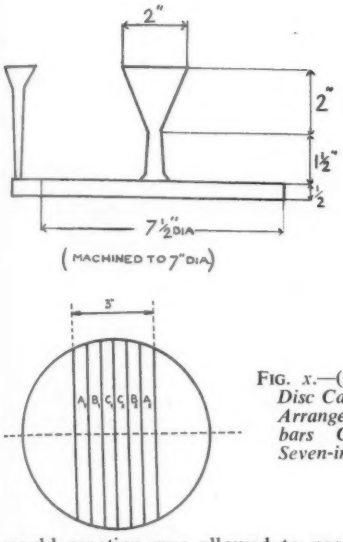


FIG. x.—(*top*) *Seven-inch Disc Casting.* (*bottom*) *Arrangement of Test-bars Cut from the Seven-inch Disc.*

mould reaction was allowed to proceed, the fractures in these bars occurred at all parts of their length; if the reaction was inhibited, the fractures were concentrated very close to the centre and occurred at a distinctly lower stress, even though the casting as a whole was somewhat sounder. He also showed that the same type of alteration in porosity distribution came about as between different melts in LM4 alloy when there were different gas-contents. Thus with some ingot material of low gas-content, which was said to have given poor results in the foundry, a certain un-fed test casting gave 58 per cent. of the tensile of a well-fed test-bar. With ingot material of higher gas-content, the corresponding test casting gave 67 per cent. of the tensile of the well-fed bars.

MR. BRACE said he welcomed criticism since it often helped to reveal new facts or problems. The possibility of the porosity ascribed to shrinkage being due to some other cause had been examined in the experimental work. A melt of 250 lb. of LM4 alloy had been taken in two parts, the first 80 lb. being cast after fluxing with 1 per cent. of a NaCl/NaF flux, although test-bars of a casting were made before and after fluxing. The remaining 170 lb. metal was degassed with 4 oz. of a proprietary compound. It was found that the untreated metal was fairly free from gas, the fluxed metal was quite sound but the degassed metal showed widely-distributed large shrinkage cavities. Sloman† has also observed that shrinkage cavities were produced when gas-free metal produced by vacuum treatment was cast. It is significant that, for practical purposes, sound metal can be rendered very porous by treatment with a gas-removing compound, and it seems reasonable, considering all the evidence, to ascribe it to shrinkage. The experience quoted by Mr. Lees on LM10 alloy only confirms data known in other alloys, namely, that the manner of distribution of the porosity can have an appreciable effect on the mechanical properties.

† M. A. Sloman. J. Inst. Metals, LXXI (1945) 391-414.

Comparison of U.K. and Foreign Steel Prices

The August issue of the British Iron and Steel Federation's statistical bulletin contains an article which compares prices of steel products in the United Kingdom, the United States, and in Continental countries. In this country the Government-controlled prices have remained unchanged since the general increase on February 27, though minor adjustments in alloy steel qualities came into effect on August 25. The very considerable margin that now exists between British and world steel prices may be seen in the accompanying table.

Iron and Steel Scrap Prices

The Minister of Supply has made an Order consolidating the Iron and Steel Scrap (Nos. 1-6) Orders, 1950-51. With a few minor exceptions, maximum prices are unchanged. The Order provides that special prices may be authorized where extraordinary collection costs are involved and for special small sizes.

The Order, which also lays down the method of calculating reductions in the scheduled prices where scrap is delivered elsewhere than at a scrap consuming works, came into force last week.

International Home Trade Price Comparison (*Per Ton of* 2,240 *lb.*).

Product.	Quantity. Of a size.	Quantity. Order.	U.K.	U.S.A.	France.	Germany.	Belgium.
	Tons.	Tons.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Angles	5	20	27 19 6	36 16 0	36 0 5	38 3 6	31 9 11
Joists	5	20	28 0 6	36 8 0	33 18 11	36 1 6	31 12 10
Plates	5	20	31 16 6	37 4 0	41 8 2	44 15 0	37 8 3
Strip	10	20	32 14 6	39 16 0	34 6 5	43 18 0	35 11 2
Rails	500	500	28 12 6	32 0 0	36 15 11	35 13 3	38 2 0
Sheets	25	25	40 2 6	42 12 0	49 10 8	51 17 6	52 5 0
Tinplate (per basis box) ..	50	50	2 15 10½	3 2 10	4 12 5*	†	†

The general basis of comparison is tested steel, delivered to consumers' station (rails and tinplate—f.o.t. makers' works). The prices are for open-hearth quality, except in the case of France and Belgium, where they are for basic Bessemer quality. The extra for open-hearth quality is approximately £3 per ton in France and £10 per ton in Belgium.

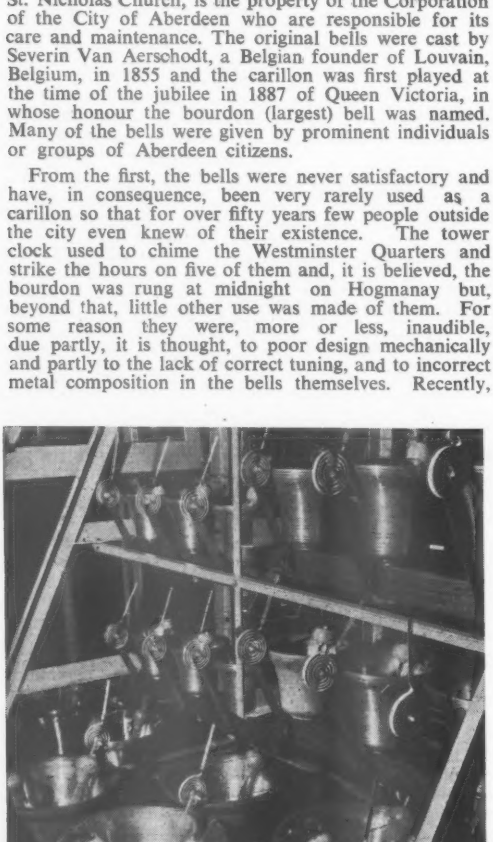
* Delivered consumers' station. † No comparable price available. Production is relatively small.

Aberdeen Bells Re-cast

Substantial Contract nearing Completion at the Croydon Bell Foundry

The Aberdeen carillon contract, now almost completed by Gillett & Johnston, Limited, bellfounders and clockmakers of Croydon, is an interesting and important one. The installation, although housed in the tower of St. Nicholas Church, is the property of the Corporation of the City of Aberdeen who are responsible for its care and maintenance. The original bells were cast by Severin Van Aerschodt, a Belgian founder of Louvain, Belgium, in 1855 and the carillon was first played at the time of the jubilee in 1887 of Queen Victoria, in whose honour the bourdon (largest) bell was named. Many of the bells were given by prominent individuals or groups of Aberdeen citizens.

From the first, the bells were never satisfactory and have, in consequence, been very rarely used as a carillon so that for over fifty years few people outside the city even knew of their existence. The tower clock used to chime the Westminster Quarters and strike the hours on five of them and, it is believed, the bourdon was rung at midnight on Hogmanay but, beyond that, little other use was made of them. For some reason they were, more or less, inaudible, due partly, it is thought, to poor design mechanically and partly to the lack of correct tuning, and to incorrect metal composition in the bells themselves. Recently, the Corporation decided to have the entire installation renewed and rearranged, and the contract for the scheme was placed with Gillett & Johnston (as announced in the JOURNAL, December 6, 1951). The old bells, fittings and framework were all dismantled and taken to the foundry in Croydon, and the work is now almost finished.



By Courtesy Tin Research Institute.

FIG. 1.—*Part of the 36-Bell Carillon Re-cast for St. Nicholas Church, Aberdeen, by Gillett & Johnston, Limited. An Additional Bell, the Bourdon, Weighing about 4½ tons, is not Included in this View.*

Details of the Scheme

The scheme, which is a comprehensive one, comprised the following:—(1) Re-casting the 37 bells and tuning them accurately according to modern practice, so that the individual tones in the bells blend with each other, and also with the other bells of the carillon. The new bourdon bell weighs approximately 4½ tons, the smallest probably not more than 28 lb. making the total weight of the bells about 12½ tons. The Company's standard bell-metal consists of an alloy of about thirteen parts copper to four parts tin, and practically the whole requirement of the contract was furnished of new metal; (2) supplying an entirely new self-contained fabricated steel framework with stationary-type fittings, roller-cranks, connections, etc., for the 36 bells of the carillon proper and balanced ringing fittings for the bourdon to enable this bell to be swung. The new frame was constructed with provision for the addition of eleven further bells in the future if desired—that is, to complete a four-octave carillon (48 bells) with the 4½-ton bourdon as the largest in the key of G sharp. If this addition is made it would then be the largest carillon in Great Britain; (3) fitting a hand clavier for the manual playing of all the bells by a skilled carilloneur; (4) arrangement of automatic swinging of the bourdon bell by a special electrical mechanism; and (5) furnishing an electrical tune-playing machine for automatic playing on fourteen of the larger bells and the bourdon by means of an electro-pneumatic mechanism.

This electro-pneumatic gear comprises a motor-driven air-compressor delivering air at 50 lb. per sq. in. to a block of powerful pistons each of which is connected to its corresponding bell clapper by cranks and wires or rods. The piston valves are electrically wired to the tune-playing machine and the piano keys respectively are connected to the starting switch.

A special 24-hour switch will be fitted to the going "train" of the existing tower clock for releasing the automatic tune playing at four pre-determined hours during the day and similarly releasing automatically the Westminster Quarters and hour striking which will, in future, be done by the electro-pneumatic mechanism. This will obviate the former laborious hand-winding of the striking and quarter trains of the clock. The time-piece, or going "train" will remain on the present hand-wound arrangement. When re-installed at Aberdeen, in the near future, the carillon will form one of the most up-to-date and comprehensive installations of its kind in the British Isles. Fig. 1 shows a part of the carillon as assembled at the Croydon works for trial playing and for recitals by the Bournville carilloneur, Mr. Clifford Ball.

EACH OF THE 2,000 EMPLOYEES of the Neepsend Steel & Tool Corporation, Limited, Sheffield, will share in the company's record trading year by receiving a special £2 bonus for each year of service. Some long-service employees will draw nearly £100 before tax is deducted.

Degassing and Feeding Techniques

Comments on the Brassfoundry Productivity Papers

Additional contributions are printed below on aspects of degassing and feeding techniques for non-ferrous castings, following upon the Papers given at the Brassfoundry Productivity Conference.

Reduction of Dust and Fumes

MR. RUTHERFORD, British Non-Ferrous Metals Research Association, commenting on Mr. Lawrie's Paper on dust and fume removal, and dealing with degassing and the use of chlorine for light alloys (which were the subject of a Paper* by Mr. E. C. Mantle), said people might not be aware that the alternative method was applicable at least under certain conditions. The method, when used for light alloys, did not produce toxic fumes, which were the real trouble with chlorine degassing, although there were still some fumes.

One of the difficulties of the process could be envisaged by giving a short explanation of the action. The advantage of chlorine with aluminium alloys was that it had a fluxing action as well as that of degassing; but with nitrogen degassing that chemical action did not take place and the degassing was slower. For that reason it was usually necessary to use some flux of the powder type which was thrown on the surface of the melt, as well as introducing the nitrogen. Yet another development, which the British Non-Ferrous Metals Research Association were just trying out, was one in which the stream of nitrogen was passed through a wash-bottle containing carbon tetrachloride. Thus was carried over some carbon in gaseous form, which passed through the metal together with the nitrogen and had a fluxing action in the same way as direct chlorine. The amount of fume which was involved, however, was extremely small as compared with when chlorine was used.

An alternative method of degassing for light alloys was by means of carbon tetrachloride in the form of tablets, but once again fumes similar to those of chlorine degassing were evolved.

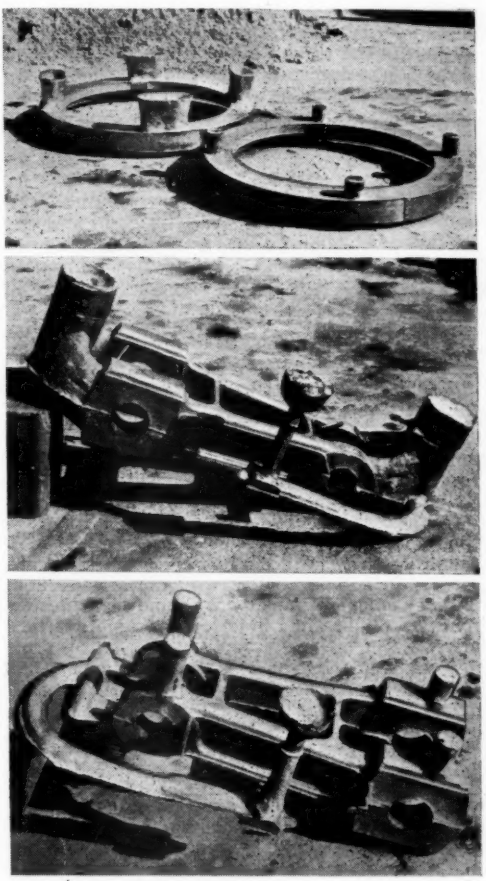
MR. W. B. LAWRIE, in reply, said he was very glad to hear that the Research Association was working on the substitution of non-toxic for the toxic materials which were at present being used, because he believed that was the right way to do it, and founders should stop using materials which required the installation of expensive, and possibly not very efficient, local exhaust ventilation. So far as dust was concerned, as distinct from fumes, it was time foundrymen started to form the castings in the moulding shop instead of in the other parts of the foundry.

Exothermic Feeding Materials

MR. R. A. MILLER has supplied the following elaboration of his remarks concerning exothermic feeding material, which were printed† following the Paper by Mr. R. A. Skinner and Mr. R. W. Ruddle.

* "Nitrogen Degassing and Metal/Mould Reaction in the Production of Gun-metal Castings" printed in the JOURNAL, July 24, 1952.

† "Insulating Feeders for Use with Copper-Alloy Sand Castings" printed in the JOURNAL, August 14, 1952.



FIGS. 1 TO 3.—*Examples of High-tensile Brass Castings made With and Without Exothermic Sleeves. Fig.* 1 *(top) shows the Reduced Size of Feeding Heads possible when Exothermic Feeding was resorted to for a Ring Casting weighing* 347 *lb. Figs.* 2 *(centre) and* 3 *(below) indicate the Runner and Riser Layout for a Double Connecting-rod Casting, respectively, Without and With the Special Sleeves.*

Degassing and Feeding Techniques

The material has led to a very substantial saving of feed metal, the "yield" in one instance being as high as 96 per cent. Actual photographs taken in the foundry of J. Stone & Company, Limited, Charlton, reproduced by permission, are shown in Figs. 1 to 3. There seems little doubt that the technical interests of the industry at large can be usefully served by making proper use of the exothermically assisted riser.

Examples

Fig. 1 shows a ring casting in a high-tensile brass alloy made first without and afterwards with the proprietary feeding material. In the first case, four feeding heads, 9 by 4½ by 6½ in. deep, were required and the weight of the casting and heads was 517 lb. In the second instance four sleeves, 2½ in. i.d. by 4 in. o.d. by 5 in. deep (wall thickness ¼ in.), were prepared from the exothermic material and then the weight of the casting and heads was 362 lb., showing a saving in metal of 155 lb. As the fettled casting weighed 347 lb., the yield without the sleeves was 67 per cent. and with the sleeves 96 per cent. Additionally there was a saving in fettling costs for the heads of 2½-in. dia. as compared with heads having a section 9 in. by 4½ in.

Figs. 2 and 3 show double connecting-rod castings also in high-tensile brass. In Fig. 2 the method of gating and feeding without exothermic sleeves is shown, whilst the other example (Fig. 3) illustrates the reduction in feed metal when sleeves were employed. For these castings the total weight of metal used for the casting shown in Fig. 2 was 73 lb. and for that in Fig. 3, 46 lb. The fettled casting weighed 35 lb., and thus the yield without sleeves was 48 per cent. as compared with 76 per cent. when sleeves were used. Once again, the saving in fettling costs in removing heads only 1⅛- in. dia., as against the normal 3-in. heads, can well be realized. The size of sleeves used for these castings was 1⅛ in. i.d. by 2½ in. o.d. by 4 in. high.

Sampling for Analysis—continued

TABLE III.—*Comparison between Total-carbon Results (per cent.) obtained from Drillings and Hollow-mill Test-pieces.*

	½ in. hollow-mill pieces.	Drillings, ½ in. dia. drill: 25 r.p.m.
Blast-furnace iron ..	4.44	4.34
Blast-furnace iron ..	3.77	3.62
Ingot mould A ..	4.09	3.98
* ,, ,, B ..	3.97	3.90
,, ,, C ..	3.84	3.74

* Total carbon of solid piece prepared with a hacksaw, 3.97 per cent.

25 r.p.m. Table III contains some of the figures, which again show total-carbon results from solid samples to be about 0.1 per cent. higher than those from drillings. Table IV shows that good reproducibility is possible with the hollow-mill technique for both total and graphitic carbon on all the cast-iron samples. The sensitivity of the method is demonstrated by its ability to bring out small differences in carbon content over the cross-sections of the slag-ladle samples. With the hematite pig-irons, the results are a little less consistent, particularly with the highest-carbon material. This is probably accounted for by the fact that this type of iron has larger and more irregularly distributed graphite flakes than the cast. irons examined. Finally, Table V presents results obtained in six different laboratories using hollow-mill samples in examining a 4 in. thick ingot mould. These results are considered to be remarkably consistent, having regard to the heterogeneous nature of the material examined.

TABLE IV.—*Determination of Total and Graphitic Carbon Using Hollowmill Samples.*

Sample.	½ in. hollow mill.	
	Total carbon, per cent.	Graphitic carbon, per cent.
Ingot mould (top section) ..	4.08, 4.08, 4.07	
Ingot mould (middle section) ..	3.96, 3.96, 3.98*	
Ingot mould (bottom section) ..	3.96, 3.95†	3.32, 3.34
Slag ladle, 3⅜ in. thick:		
Inside (½ in. from edge) ..	3.65, 3.64	3.05, 3.06
Centre	3.68, 3.71	3.27, 3.28
Outside (½ in. from edge) ..	3.70, 3.71	3.17, 3.17
Slag ladle, 2⅜ in. thick:		
Inside	3.85, 3.85	3.15, 3.13
Centre	3.79, 3.78	3.09, 3.12
Outside	3.78, 3.82	3.15, 3.15
Hematite pig-iron A	4.15, 4.18, 4.10	
,, ,, B	4.25, 4.31, 4.29	
,, ,, C	4.61, 4.59, 4.52‡	

* ½ in. hollow-milled sample, 3.98, 4.00 per cent.
† Hacksawn samples, 3.97, 3.97 per cent.
‡ ½ in. hollow mill, 4.54, 4.52 per cent.

TABLE V.—*Co-operative Examination of a 4 in. thick Ingot Mould using the Hollow-mill Sampling Technique (½ in. mill).*

Operator.	½ in. hollow-mill samples.		Hacksawn samples.
	Total carbon, per cent.	Graphitic carbon, per cent.	Total carbon, per cent.
1	3.96, 3.95	3.34, 3.32	3.97, 3.97
2	3.90, 3.95, 3.96		
3	3.95, 3.99, 4.07, 4.10	3.24, 3.29, 3.36, 3.38	
4	4.01, 4.07		
5	4.01, 3.99, 4.05, 4.05	3.33, 3.31, 3.35, 3.34	
6	3.97, 3.94, 3.98		

Conclusions

The conclusions reached by the sub-committee can be summarized thus:

(1) Solid samples of suitable size and weight provide the best means of retaining, in a single analytical specimen, the correct proportions of total and graphitic carbon.

(2) When solid pieces cannot be obtained easily, quickly and conveniently by sawing, a ½ in. hollow milling cutter is recommended. Small cylindrical pins can be produced with this tool from almost any position which can be sampled by drilling.

(3) If drilling has to be employed, the most suitable procedure appears to be to employ a ½ in. dia. drill operating at a speed not greater than 25 r.p.m. to give a sample weighing about 1 gm., the whole of which is used for a single determination.

(4) Separating a drilled sample into fractions by sieving and using the correct proportions of each of the particle sizes in carbon determinations seems to be a less satisfactory alternative. Drillings obtained by conventional methods at moderate or high speeds are quite untrustworthy.

Manufacture of High-quality Steel Castings at an Economic Price*

Discussion of the Paper by Mr. J. J. Dewez at the Buxton Conference

The CHAIRMAN (Dr. C. J. Dadswell), introducing the Paper "Manufacture of High-quality Steel Castings at an Economic Price," said it was one of the most important papers in the whole Conference and formed the exchange paper from *l'Association Technique de Fonderie de Belgique*. It was presented by Mr. Dewez, works manager of Emile Henricot, which was the largest steel foundry in Belgium and one of the largest in Western Europe. Since 1945, the Henricot foundry had spent much money on mechanization because of the economic change in cost of labour, but the Paper was evidence that their technique had been kept at a very modern and high standard. Mr. Dewez had just spent two and a half months in America and had only arrived back in Europe the previous week; it was therefore a great kindness on his part to come straight away to this country to present the Paper personally.

[Mr. J. J. Dewez then presented his Paper.]

Annealing Before or After Fettling

MR. R. F. OTTIGNON (K. & L. Steelfounders, Limited) said the Author had referred to the rough machining of castings in order to reduce machining allowance before they were sent out to customers, and in that connection an extremely worth-while trend was taking place, but Mr. Dewez had specifically mentioned that the rough machining should take place before annealing, which implied that fettling must also take place before annealing. There was, however, a wide difference of opinion in the foundry world as to whether annealing should take place before or after fettling. In his foundry it was done before fettling and he knew of two large foundries which for many years had done their heat-treatment after fettling, but were now in the process of reorganizing their shops in order to anneal first. He would be interested to hear from Mr. Dewez further details as to why he preferred the reverse. Obviously it would save the double heat-treatment of castings where defects had to be corrected by welding, and this aspect might increase in importance as the amount of rough machining done by the foundry was increased.

MR. DEWEZ, in reply, said that on ordinary steel castings his firm did the rough machining first. The point had not been reached where it was certain that all castings would not show defects after machining, and sometimes the top part of the casting had to be welded, and so one treatment was saved. During his visit to the United States he had seen many foundries which were annealing before fettling, which he believed was for two main reasons: first, Americans were not so particular about the external appearance of the castings as were founders in Europe and they were saving one cleaning, and, secondly, American quality was very good. For special steels, it was very often impossible to fettle the casting as-cast, and they had to be first passed through a high-temperature treatment and a further treatment to reduce the hardness, and then rough-machined before the final treatment.

MR. OTTIGNON interjected that in addition to the points previously mentioned, there was an increasing body of opinion which thought heat-treatment before fettling brought the advantage of scaling, which would reduce the amount of dangerous dust which was created at the point of the fettling chisel.

MR. DEWEZ, in reply, agreed that there was still much controversy on the subject. In America he had seen many jobbing foundries using very large shot-blasting machines, and founders found they had more profit by adopting that method of shot-sand-blasting and descaling, because they did not have to pass the castings through the furnace twice. Others were annealing even before the runners were knocked off. He did not think, however, that under the prevailing conditions in the foundries of this country it would be profitable, unless one could be quite sure of the quality.

Quality Standards

MR. HALL emphasized a very important statement which had been made by Mr. Dewez: they had been faced for a long time with a sellers' market and Mr. Dewez had said that if he found castings of poor quality which could be reclaimed, then it was better, under those conditions, to scrap those castings in order to induce a high-quality standard into the works again. Further, he asked the Author to give members a rough idea of the number of so-called non-productive personnel in his organization. From a perusal of American productivity reports, it seemed that the more non-productive personnel one carried, the more efficient the foundry appeared to be, which was rather a striking contrast to the view normally held.

MR. DEWEZ replied that the percentage of people engaged in control and checking in his foundry, relating to the direct and indirect labour and taking into consideration all the personnel of power plants maintenance department and transport yards, was six per cent. When a control was started, one usually thought it would be very costly, but after a certain time people specialized in their jobs.

MR. HART asked for further information of the magnetic testing equipment used by Mr. Dewez and as to whether ink or powder was used as the detecting agent; also, what percentage of production castings was checked by this method.

* Paper printed in the JOURNAL, July 10 and 17, 1952.

High-quality Steel Castings—Discussion

In reply MR. DEWEZ said his foundry was using two types of magnetic testing: one, which was used for lengthy castings, was a device in which a liquid was used, made up of oil and a magnetic powder, and the second one was made by the (American) Magnaflux Company and used a dry powder. The castings inspected by the latter method were high-pressure castings such as valves, locomotive cylinders, and the like, and also "security" castings such as those required for passenger coaches, locomotives and tenders, and the automobile industry. Naturally, all the castings could not be inspected by the method because a one hundred per cent. inspection was impossible.

Cleaning Details

MR. FINCH, referring to the mention which had been made by Mr. Dewez of a light-weight hammer for dressing which retained its power, said that was not possible in this country, where a reduction in weight would mean a loss in power.

MR. DEWEZ replied that the light-weight pneumatic hammer to which he had referred was American made. Many kinds had been tried from different countries and the Ingersoll-Rand pneumatic hammers and the Chicago Pneumatic Tool concern's hammers were the best, and during the past year had made still more progress. He had seen some very interesting hammers at the Foundry Convention in Atlantic City.

"Stone"-blasting

MR. WELLS enquired whether Mr. Dewez normally arranged for two shot-blasting operations —one prior to annealing and the other a descaling shot-blasting treatment after the annealing. He supported the practice mentioned by Mr. Ottignon; most castings were acceptable to the customer after tempering treatment but usually after an anneal one needed a descaling treatment.

MR. DEWEZ replied that a shot-blasting process was being used for medium and small castings before annealing, but for large castings sand-blasting—not actually using quartz sand but a special hard stone found in Belgium—was being used which did not carry with it the danger of silicosis. It had been used for twenty-five years by operators working on blasting inside chambers and they had not contracted silicosis. For the descaling operation, shot-blasting was used. In that case the process was more expensive because two cleaning operations were involved, which was the reason why some mass-production American steel foundries used the one annealing process before fettling.

A MEMBER asked whether he was correct in assuming that Mr. Dewez used sub-zero temperatures rather than normal room-temperatures for the quality-control checks.

MR. DEWEZ replied that all their tests were embodied in quality control of the steel. Room-temperature tests were also made and it was found that the curve of the temperature and the results obtained were very important indications of the quality of the melt. When one considered castings working sometimes in very cold weather at −30 deg. C. in countries like the North of Sweden, for instance, then it was realized that it was a necessity to check their quality at −40 deg. C. At the start results were very deceptive and made necessary many changes in the process.

Electric-furnace Stress-relieving

A MEMBER, referring to the Author's remark that stress-relieving treatments had to be made in electric furnaces because an even distribution of temperature was impossible to obtain under 750 deg. C. with open-flame furnaces, asked whether, without querying the efficiency of the electric furnace, economics did not very largely enter into the question. How did the more expensive electric furnace compare with a gas-fired furnace?

MR. DEWEZ replied that in his experience, in order to produce uniform castings, an electric furnace should be used for tempering. In his foundry, the tempering and stress-relieving treatment was carried on during the night-time, when power was cheaper. Castings tempered in open-flame furnaces were not regular in hardness and a certain percentage had to pass through another heat-treatment process because they were too hard or too soft. In the summation, the electric furnace was found to be cheaper.

MR. FINCH remarked that one point which had not been fully brought out was that Mr. Dewez attempted to make the casting in the foundry and not in the fettling shop. In the average British steel foundry at the present time the total direct labour in the fettling shops exceeded the total direct labour hours of coremakers and moulders, and he wondered if the Author could give his figures for those sections and also the welding man/hours per ton—in Britain, if below four man/hours per ton were required, founders were quite pleased.

MR. DEWEZ replied that the total man/hours per ton in the fettling shop of one of their large foundries, as compared with the man/hours in the moulding department, was as 31 to 53, or approximately 60 per cent. As he had no details of the number of man/hours per ton spent on welding, he was unable to reply to that part of the question.

Departmental Organization

MR. JONES said that the Author had stressed the importance of the foundry process organization. Taking into consideration Dr. Dadswell's Presidential Address in which he advocated the breaking-down of foundry personnel, did not Mr. Dewez think the foundry process office was one of the most important places where that should be envisaged? Very few technicians would have the nerve to call themselves masters of all the trades in the foundry industry, and as the training of personnel by means of short terms spent in all the departments of a works tended to make them "Jacks of all trades and masters of none," he would be glad if Mr. Dewez could enlighten them as to how he organized his planning department.

MR. DEWEZ replied that in the organization of their methods department their best men had been introduced into the foundry because in such matters the foreman who received details of the work to be done was of less importance—although he had to

be of a good type and a good supervisor, he had only to do what was set out for him. If he did not agree with this, he was free to go to the methods department and raise any objection. The head of the methods department was a man who had been trained completely in the foundry; they had taken a young man who was very receptive and very clever and had put him through the technical high school in the evenings and also through the different departments of the foundry. A new generation was now being trained of the same quality by affording just the same opportunity. They had in their home town a technical industrial school which had been established by the plant, and they sent all their boys there for three or four years, some taking mechanical engineering and some metallurgical engineering, the only initial qualification being that they should have been good students in the primary school. After that, the firm paid the best men to go to Charleroi, about 20 miles away, for night courses. To do that the men were permitted to work from 7 a.m. until 1 p.m., when they took the train to Charleroi for the evening courses. By those means, the firm now had between 15 and 20 young men who were being prepared to take over executive jobs when needed.

MR. KEEBLE emphasized the point brought out by Mr. Dewez, that in a foundry something like one hundred tons of material were moved in order to produce one ton of castings and said that in a survey of the operations performed in foundries of all types it had been estimated that between one and two hundred tons of materials were moved. Material handling was one branch in which all founders could improve their efficiency, and in a relatively simple manner.

Composite Structures

He had very much liked the advice that founders should look to the future and the emphasis which had been laid upon composite constructions, *e.g.*, the welding of castings to castings, which was something all should emulate. There was no merit in producing a casting weighing thirty-five to forty tons if it could be broken down into four or six units assembled together by other means of construction. A large casting might be admirable from the viewpoint of the foundry floor, but from the viewpoint of economics and efficiency it was better to break it down and approach the job in a simpler way.

A minor point he had noticed in the Paper was the encouragement to use heavy fuel-oils, because of their cheapness, but he would like to hear if the lecturer had experienced any trouble due to excessive corrosion of valves and pipe-lines owing to the acid content of low-grade fuel-oils. Also, had Mr. Dewez had any opinions on the use of the snap-flasks, which were in wide use in the United States of America.

MR. DEWEZ, in reply, confirmed the figure of between one and two hundred tons for the handling of material and said that installation of handling equipment was something which could be tackled very easily; indeed, it was impossible to re-organize a foundry without initially taking that into consideration. In his own foundry, castings were handled by fork-lift truck and there was a very large storage plant where all the heavy materials were stored. For instance, in storing bricks for the roofs of electric furnaces, the bricks were taken out of the wagon and arranged in accordance with the number required for one roof, so that the men unloading them knew that they had to put so many of one shape on to each store pallet. Whenever a complete set of bricks was required two pallets were sent to the foundry, which meant that the handling was only done twice. His firm were also trying to avoid the transport of fuel by installing storage bunkers and carrying all the fuels to the different parts of the plant without double labour, and with much care on the part of the maintenance department, and after a few set backs, they were managing it. It was a rule that nothing should be put on the ground, and even when building was in progress the bricks from the lorry were put on to pallets, so that they were handled only twice.

The question of composite construction was very important, and in the United States he had seen a lot of castings which were made, under rigid inspection, by welding cast parts together. The fact that specifications called for more care in steel castings than in the welded construction of steel was founders own fault because on so many occasions bad castings had been supplied to customers that they had become sceptical.

With regard to the heavy fuel-oil, his firm had not so far experienced any corrosion but as they had only used it for two years, corrosion might yet occur. As far as the snap-flask technique was concerned, he had seen it used in America in a foundry making 800 tons a week and there were no boxes at all. The foundry was using that technique, even up to sizes of 40 by 40 by 40 in., and it resulted in a great improvement in handling in the foundry and a figure for the productive manhours per ton of below 80. One man was making 250 moulds in eight hours.

A MEMBER asked whether the Author had any very definite ideas on the advantages of lip-pouring as distinct from bottom-pouring, to which MR. DEWEZ replied that small castings were better in appearance and quality when they were lip-poured, and the possibilities with that kind of pouring were really astonishing

Vote of Thanks

MR. P. C. FASSOTTE, in proposing a vote of thanks to Mr. Dewez, said it might be of interest to sketch the background to this Paper. Some twenty miles south-east of Brussels there was a large well-known steel foundry, which was ranked by visitors as one of the most efficient in Europe. An American expert, last October, went through this plant and expressed the opinion that in equipment and performance it could be compared with the best in his own country. A man of scientific training, acquired in the hard school of Brussels University and later in the Carnegie Institute in America, was given control of this foundry years ago and ran it and still runs it to-day. Being a good

manager he knows the value of a good staff and he has surrounded himself with first-rate personnel. This man is Mr. Dewez, who had come to this Conference and for the benefit of members had lifted the veil on how it was done. He enunciated the principles on which his policy was based and proceeded to outline in detail the manner of execution. It was a story of infinite pains taken, infinitely repeated. The Paper was built-up, not from flimsy fabrics of theory, but out of the tough metal of industrial experience. How pleasing for the numerous enthusiasts in the industry to hear it said that the quest for low costs lay along the highway to quality It was a Paper full of precious guidance, and one which would comfort and refresh a foundry manager in distress. Members were grateful to Mr. Dewez for having prepared it, for having come in person to deliver it, and also to the new president for having persuaded Mr. Dewez to do this. It was a fine start to a presidential year.

MR. DOUGLAS E. CATTON, in seconding the vote of thanks, said it gave him very great pleasure to do so because the Author was a friend of his and he and his staff had on several occasions visited Mr. Dewez's foundry in Court-Saint-Etienne. In fact, the two foundries worked in very close co-operation. Whilst he reiterated the remarks made by Mr. Fassotte regarding Mr. Dewez and his foundry, there was one point which he wished to emphasize. Although all foundrymen tended to exaggerate, the fact he was going to recount was true, but nevertheless it was difficult to believe. In his Paper, the Author's whole theme had been quality and quality control, and during one of his early visits to the Henricot foundry he had asked Mr. Dewez what was his percentage of reject castings. Mr. Dewez had replied, "We never get a casting returned from our customers; we should be horrified if such a thing occurred!" That was the result which Mr. Dewez was obtaining in his foundry, and he was achieving it by quality control. The Chairman had said that Mr. Dewez had written a classic Paper, but he also controlled a classic foundry, and one which members would do well to emulate.

The vote of thanks was carried with acclamation and MR. DEWEZ expressed his thanks both personally and on behalf of *l'Association Technique de Fonderie de Belgique*.

E.C.E.'s Economic Report

A bulletin published recently in Geneva by the secretariat of the United Nations Economic Commission for Europe summarizes developments in the economic situation in Europe in the first quarter and part of the second quarter of the year. It points out that steel output in all the major Western European producing countries, except Belgium and Luxembourg, continued the upward trend of the first quarter of 1952 over that of the fourth quarter of 1951. Steel shortages which had been holding back engineering output and exports in the United Kingdom seemed to be well on the way to solution—though not without some cost in dollars.

Solid-fuel Appliances.—Of interest to architects, builders, local authorities, householders, and stove-grate founders, List No. 5 of recommended domestic solid-fuel appliances has now been published by the Coal Utilisation Council, price 6d. Prepared in consultation with the Ministry of Fuel and Power, the list, which supersedes No. 4 (issued in December, 1950) gives details of all domestic solid-fuel appliances which comply with the prescribed standards of efficiency and also provides information about the types of fuel suitable for them.

Latest Foundry Statistics.—According to the August Monthly Statistical Bulletin issued by the British Iron & Steel Federation, there was in August a reduction of 1,790 in the number of people employed in ironfounding as compared with a month earlier, but a gain of 2,935 as compared with a year ago. The total now stands at 153,665. Employment in the steelfoundry industry has increased over the year from 19,084 to 20,814. In July the weekly average production of liquid steel for conversion into castings was 8,500 tons as compared with 10,600 tons in June and 8,600 in July 1951.

U.K. Delegates to Schuman Plan

It was announced on August 23 that the United Kingdom delegation to the High Authority of the European Coal and Steel Community would include advisors from both management and labour of the coal and iron and steel industries. The following advisors have now been appointed.

Iron and Steel. The Iron and Steel Corporation of Great Britain and the British Iron and Steel Federation have nominated MR. E. W. SENIOR, commercial director of the Federation. They will also make other experts available to advise on particular matters as occasion arises. The Iron and Steel Trades Confederation has nominated MR. HARRY DOUGLASS, assistant general secretary. The National Union of Blastfurnacemen, Ore Miners, Coke Workers and Kindred Trades has nominated MR. J. OWEN, general secretary.

Foundry Meeting at Northampton

In order to foster the growing interest in foundry technical activities in the Northampton district, the East Midlands branch of the Institute of British Foundrymen will be holding a meeting on Saturday, October 11, commencing at 6.0 p.m., in the All Saints' Buildings, Horseshoe Street, Northampton. The programme includes a talk, "Some comparison of British and American Foundry Practice," by P. A. Russell and F. G. Butters, and light refreshments will be provided. The branch extend a cordial invitation to all members in the area to attend and to propagate the activities of the Institute in the Northamptonshire area.

Carbon dioxide as a coolant in carbide tool grinding has proved its usefulness in extensive tests conducted at Cadillac Cleveland Tank Plant according to John Kwolek writing in "Iron Age" August 14. The advantages, he states, are many and cost comparisons with standard coolant or dry grinding are favourable when due precaution against waste is exercised.

United Kingdom Trade in August

United Kingdom exports in August were valued at £180,700,000. Comparison of the total with that for July is misleading because there were only 25 working days in August, against 27 in July, but August showed a decline of 6 per cent. in the daily rate of export as against July. For July and August together, exports averaged £194,300,000 a month, compared with £209,400,000 in the second quarter and £239,500,000 in the first quarter.

Imports into the United Kingdom in August were valued at £263,400,000. During the first eight months of this year imports have been 5 per cent. less than in the corresponding period of last year. With re-exports reduced to £9,000,000, compared with an average of £14,000,000 in the first seven months of this year, the excess of imports (c.i.f.) over exports and re-exports (f.o.b.) was £73,700,000, compared with £69,300,000 in July and £78,400,000 in the first half-year.

The provisional total for United Kingdom exports to North America in August was £21,500,000. Allowing for the different number of working days, this represents a daily rate of export 8 per cent. less than in July and 4 per cent. less than in the second quarter. Exports to both the United States and Canada shared in the reduction, but whereas the July-August average for shipments to the United States was 7 per cent. less than in the second quarter, for Canada the average for July-August remained 22 per cent. more than the second quarter average.

National Foundry Training Centre

Interested readers who have in their foundries youths who are suitable candidates to attend the four-week training course at the National Foundry Craft Training Centre at West Bromwich, are asked to note that the next available courses will commence on the dates mentioned below. Applications to attend the courses should be addressed to R. Forbes-Baird, 117, Church Lane, Handsworth Wood, Birmingham 20.

Term No.	Commence.	Terminate.	Course No.
42	Nov. 24	Dec. 10	3
43	Dec. 29	Jan. 23	4
44	Feb. 2	Feb. 27	1

With the exception of term 42 (course 3), all other courses at the National Foundry Craft Training Centre for the remainder of 1952 are fully booked.

Foremen's Training Course Next Year

The foundry foremen's training course organized by the Institute of British Foundrymen will next year again be held at Ashorne Hill, Leamington Spa, the dates being Thursday, April 23 to Saturday, April 25. The provisional programme is as detailed below:—

Thursday evening, April 23: Assembly 4.00 p.m. onwards; technical film displayed at 8.30 p.m.

Friday, April 24: *Morning session*—Address by the president; lectures on "The Place of the Foreman in Management" and "Producing Castings for the Buyers' Market," *Afternoon session*—Lecture on "Problems of the Foreman of the Small Jobbing Foundry. *Evening session*—Discussion groups.

Saturday, April 25: *Morning session*—Lectures, "The Foreman's Part in the Training of Apprentices" and "Methods of Controlling Quality." *Afternoon session*—Lecture on "Heavy Castings for Power Hammers."

City and Guilds Advisory Committee

Resignation of Mr. S. H. Russell

Mr. S. H. Russell, past-president of the Institute of British Foundrymen, has intimated his desire to resign from the chairmanship of the advisory committee on patternmaking and foundry practice in connection with the City and Guilds of London Institute examinations in these subjects. This resignation terminates a remarkable piece of work carried out by Mr. Russell over a period of many years.

It was in 1930 that the City and Guilds of London Institute responded to a suggestion made by the Institute of British Foundrymen to organize national examinations in foundry practice and in patternmaking and an advisory committee was appointed to advise on the organization and conduct of these examinations with Mr. E. R. Briggs of Rugby as chairman and Mr. Russell as vice-chairman. A few years later Mr. Briggs, resigned and Mr. Russell was appointed his successor.

During the intervening period these examinations have become an integral part of the national foundry educational system. The number of candidates has increased from 84 in 1932 to 825 in 1952 and the number of centres preparing candidates has also grown proportionately. The value of the examinations is being increasingly recognized as a technical qualification for men holding positions of importance and responsibility in the industry. Much of this success is due to the very devoted and able work which Mr. Russell has carried out as chairman of the committee. The intimation of his resignation will be received with very great regret coupled with a feeling of gratitude for all that he has done over the past 22 years.

Staveley Iron and Chemical Valuation

Following the nine-day hearing before the Iron and Steel Arbitration Tribunal in London in July, the tribunal has determined that the value of the 8,000,000 ordinary shares of £1 each of the Staveley Iron & Chemical Company, Limited, Chesterfield, for the purposes of Section 15 of the Iron and Steel Act, 1949, is 20s. 6d. per share. A Ministry of Supply statement says that an announcement of the amount of British Iron and Steel compensation stock to be issued to the former stockholders, the Staveley Coal & Iron Company, Limited, will be made later.

The award will involve a total payment for the shares of £8,200,000. The company sought £8,750,000, equivalent to 21s. 10½d. per share, against the Ministry of Supply's offer of £5,100,000, or 12s. 9d. per share.

Congratulations

With the publication of its July issue, our very highly esteemed American contemporary *Foundry* (or *The Foundry*, as it was known for so long) celebrates its diamond jubilee. We ask the Editor, Mr. Frank Steinebeck, to accept our warmest congratulations. The *Foundry* was started by the late Mr. John Penton sixty years ago and was, to the best of our belief, the first magazine ever to be published which was entirely devoted to serving the interests of the foundry industry.

THE BRITISH TRANSPORT COMMISSION is to spend £950,000 on modernizing King George Dock, Hull. Most of this sum will be absorbed in replacing the 45 cranes with new electrical equipment. The dock, which was opened in 1914, is the largest on the north-east coast.

Personal

MR. JOHN SISSENER, the well-known consulting metallurgist of Norway, has been appointed by the "United Nations" organization to act as adviser to the Israel government for their foundry industry.

MR. FREDERICK LLEWELLYN, chief timekeeper and wages manager of Swan, Hunter & Wigham Richardson, Limited, shipbuilders, of Wallsend (Northumberland), has retired after 42 years' service with the company.

M. PAUL-HENRI SPAAK, the former Belgian Prime Minister, has been elected president of the assembly of the European coal and steel community. His term of office is to extend to the beginning of the 1953 session, which is expected to be held in May.

MR. J. P. ANDERSON, C.B.E., has sailed for Canada with his family to take up his appointment as vice-president and general manager of the Dunlop Tire & Rubber Goods Company, Limited, Toronto, in succession to Mr. D. B. Collett, who returns to England to join the main board.

MR. JOHN CARTWRIGHT sailed last week for Stockholm to take up his duties as resident technical representative of Foundry Services, Limited, in the Scandinavian Countries. He will work in close co-operation with the company's established agents in the various countries. It is interesting to note that Mr. Cartwright, apart from his foundry activities, is something of a writer, and had his first novel "False Crest" published last month.

MR. STANLEY WALTER HUGHES, chairman and managing director of H. M. Hobson, Limited, Wolverhampton, aircraft engine accessories manufacturers, sailed on September 17 for Australia. He hopes to increase his firm's export trade with the rapidly-expanding Australian aircraft industry. On his return journey, Mr. Hughes is to fly across America calling at New York for a visit to the firm's American licensees. Mr. Hughes recently completed 50 years' service with the firm.

MR. L. W. CLAXTON, works manager and joint managing director of Sheffield Twist Drill and Steel Company, Limited, has retired from the Board. Newly-appointed directors are Mr. J. Whorton, a sales representative for many years, Mr. C. Woodhouse, warehouse manager, and Mr. N. H. Waple, metallurgist. The present chairman and managing director is Mr. Alex. A. Dormer. Mr. J. S. Webster, a director of Sheffield Twist Drill & Steel Company, Limited, has been appointed works manager.

Iron and Steel Training Course

A two-year course on iron and steel manufacture and processing, leading to the City & Guilds Certificate, is to begin in Clydesdale College, Mossend, this week. The new course, in which Mr. John Lang, of the British Iron & Steel Trades Council, is taking a deep interest, is to be conducted by Mr. John Russell, A.R.C.T., of Clyde Alloy Steel Company, Limited, Motherwell. Dr. D. J. Pearce, B.Sc. (Hons.), M.Sc. (Eng.), principal of the college, told our correspondent that each lecture would be given on a Wednesday and repeated the following Thursday. Time for discussion would be allowed each evening, and visits would be organized to various works to supplement lectures. Another course which Mr. Pearce expects to introduce soon is one for executives in the industry.

Obituary

MR. K. A. THOMSON, a director of A. H. Hunt, Limited, manufacturers of capacitors, of London, S.W.18, has died.

MR. JAMES MCDONALD MANSON, a former general manager and secretary of the Tyne Improvement Commission, has died at the age of 86.

MR. JAMES EAGLES, formerly head of the engineering department of Darlington Technical College, and later principal of the college, died recently.

MR. GEORGE MALTBY, a director and former manager of the Glasgow branch of Redpath, Brown & Company, Limited, structural engineers, of Edinburgh, died recently.

MR. JOHN DYSON who died at his home at Chapel-Allerton, Leeds, was formerly mnaging director of Frederick Dyson & Sons, Limited, Steander Foundry, East Street, Leeds. He retired in 1945 after 60 years' association with the firm.

MR. GEORGE MONRO, proprietor of Bell & Company, ironfounders, of Lelia Street, Belfast, died in the Royal Victoria Hospital, Belfast, on Friday last. He had been admitted suffering from very serious injuries received when three tons of scrap metal fell on him following the collapse of a staging at the foundry. Mr. Monro was 64 years of age.

George Kent's Foundry Transferred

The foundry of George Kent Limited was recently transferred from Biscot Road, Luton, to newly-constructed premises to be known as the Lea works, some 2 miles distant. The move is the first part of a major plan to embody all foundrywork and the mechanical side of instrument manufacture in the new works. The panel shop has also been transferred but this is only a temporary measure.

The new foundry, which incorporates modern sand-handling and reclamation plant, caters for all non-ferrous castings required by the firm for their water-meter bodies, doors and cases for meters and large parts and other castings for instruments. All are produced by sand casting from metal melted in crucible furnaces. The actual move occupied the second week of the firm's annual holiday period and thus no productive time was lost, the first week's cast of 11 tons being only two tons below normal.

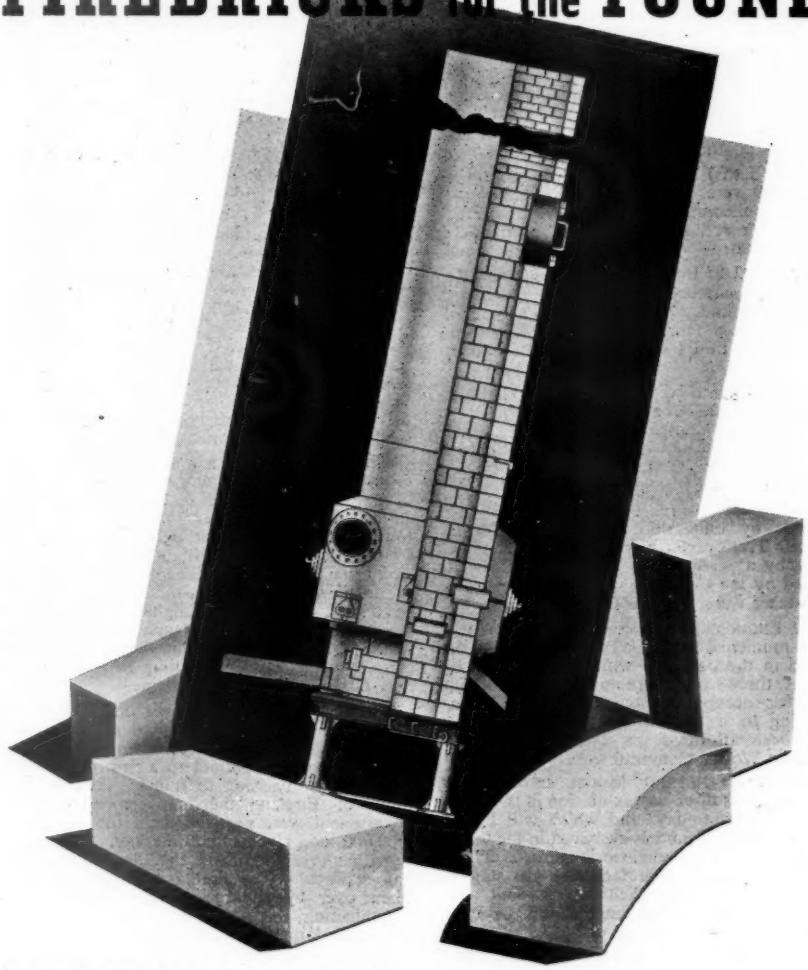
M.S.A. Licensing Proposals

Fifty new licensing proposals for the foreign manufacture of American products have been announced by the Mutual Security Agency Mission to the United Kingdom, 1, Grosvenor Square, London, W.1. This brings the total number of proposals to 277. Among the latest licensing proposals are the following:—

Acro Manufacturing Company, Columbus, Ohio (switch products); Aero Manufacturing & Machining Company, Muskegan Heights, Michigan (tools, jigs, special machines, and hydraulic equipment); Interstate Manufacturing Corporation (machine tools); Continental Industrial Engineers, Incorporated, Chicago (industrial furnaces, dryers, and other equipment); Pittsburgh Annealing Box Company, Pittsburgh (protection of steel); Scott & Williams Inc., New York ("Hydropulse" hydraulic pump); Square D Company, Detroit (electrical control and distribution equipment); Thompson Grinder Company, Springfield, Ohio (surface grinders); Townsend Company, New Brighton, Pennsylvania (rivets and rivet-setting gun).

GLENBOIG

FIREBRICKS for the FOUNDRY



The **GLENBOIG** Range includes

42/44% Al_2O_3: **GLENBOIG A.I – GLENBOIG A.I CROWN**

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EXPORT AGENTS: GENERAL REFRACTORIES LTD., GENEFAX HOUSE, SHEFFIELD, 10

News in Brief

GREENOCK DOCKYARD COMPANY, LIMITED, announce that they are to build two tankers, each of 16,250 tons dw.

A SURVEY of economic and commercial conditions in Paraguay was published by H.M. Stationery Office on September 23, price 2s. (post free 2s. 3½d.).

THE UNITED KINGDOM trade and navigation (import and export) accounts for August were published on September 19. Copies can be bought from H.M. Stationery Office.

QUANTITIES of scrap metal have been salvaged from the blockship Thames in Holm Sound at the eastern approach to Scapa Flow. The operation has been carried out by Metal Industries (Salvage), Limited.

IN COSELEY'S (Staffs) scrap-metal drive, more than 100 tons of metal were collected: One old lady told the Corporation collectors that she had a spare bed which could go for scrap if they would dismantle it and carry it downstairs—which they did.

AMENDMENT No. 2 to B.S. 1400: 1948, Copper-alloy Ingots and Castings, has been published by the British Standards Institution under reference No. PD. 1465. It concerns the chemical-composition and mechanical-properties clauses of B6-I brass ingots and B6-C brass castings.

THE NEW Birmingham district offices of Metropolitan-Vickers Electrical Company, Limited, and the Edison Swan Electric Company, Limited, at 10/12, Hospital Street, were opened on Wednesday, September 10, by Alderman W. S. Lewis, C.B.E., chairman of the Midlands Electricity Board.

MORE THAN 250 awards for 25 years' service have now been made by Lancashire Dynamo & Crypto, Limited, at their Trafford Park works. The total was raised recently by a presentation, made at the annual dance organized by the Company's Social and Athletic Club, when watches were given to five employees.

THE PRINCEP ENGINEERING COMPANY is to take over Walsall's first municipal flat-type factory block—the first of its kind in the country—which is now nearing completion. A three-storey structure, it was originally intended for occupation by three smaller concerns, but, owing to its growth, Princep Engineering Company has been allocated the entire premises by the Walsall Public Works' Committee.

THE KEIGHLEY AND DISTRICT MODEL ENGINEERING SOCIETY, which opens its three-day exhibition in the Temperance Hall, Keighley, to-day, and which will be by far the largest exhibition of models ever seen in the town, has the full support of local engineering firms. Three of Keighley's leading lathe manufacturers are staging exhibits along with makers of machine-tools, and also one firm associated with marine engineering. British Railways are loaning three models worth £3,750.

RUBERY OWEN & COMPANY, LIMITED, Darlaston, have appealed to employees to assist the firm in saving thousands of pounds a year by using welding electrodes to the end. The ends are precious, states the firm in its appeal, and few people realize that, if even three inches of every electrode is thrown to scrap in a period of 12 months, the number that the firm use in that time would enable these ends to stretch from Darlaston to Lands End. Therefore the firm asks that ends should be used for tacking and that new ones should be used only for continuous runs.

ABOUT 400 employees of Norton Industries, Limited, Ettingshall, Wolverhampton, and their associated companies, the Priorfields Foundry Company, Limited, Ettingshall; Loxdale General Engineering Company, Limited; J. Norton & Sons (Metals), Limited; and Bradley & Portway Forgings (Wednesbury), Limited; last weekend travelled in 11 motor coaches to Weston-super-Mare for their outing. They were accompanied by Mr. J. Norton (chairman), Mr. J. Dennis Norton and Mr. H. Foley (directors). The whole cost of the outing was met by the directors.

FOLLOWING A SEARCH which has been going on for some time to acquire further premises, the firm of J. Hobkirk, Sons & Company, Limited, iron and non-ferrous founders, of Ampthill Road, Bedford, have recently purchased an industrial site formerly occupied by Saw Mills (Bedford), Limited, at Kempston Hardwick. The new site comprises 1½ acres of land with substantial brick buildings and is situated approximately one mile from the existing 2-acre site in Ampthill Road. The company has for some time found the present premises inadequate for the amount of work in hand.

EMPLOYERS are being forced to restrict labour demands to a minimum because of the general industrial uncertainty, Mr. J. E. Sitch, employment exchange manager, told Smethwick Local Employment Committee on September 18. He added that "a somewhat disquieting decline" in vacancies was shown; in August there were 312 vacancies for men and 55 for women compared with 450 for men and 145 for women in March. On September 2 only one firm in the entire Smethwick area had current vacancies for labourers. The number employed decreased by 1,783 (982 men and 801 women) since the last report.

NOTTINGHAM INDUSTRIAL ACCIDENT PREVENTION GROUP is to form a junior section on the lines already established and proved successful by the Birmingham Industrial Safety Officers' Group. The decision followed a talk to the Nottingham Group on September 17 by Major A. L. Atwill, who was primarily responsible for the development of the Birmingham junior group of which he is chairman. Major Atwill emphasized that not one Birmingham industrialist had adversely criticized the scheme and that those firms which had hitherto thought themselves to be already giving sufficient safety training to young workers were now anxious to join the scheme.

ONE OF THE LARGEST factories on Newhouse Industrial Estate, owned by Vactric, Limited, manufacturers of electrical appliances, is to close down. All future work is being put on sub-contract to a firm near London. Explaining their decision to transfer their business to the South of England, the management stated that the Government were pressing them for repayment of the £500,000 loan given some time ago. A payment had to be made by the end of March, a date considerably sooner than expected. The building on the Estate had been taken over by a large electrical concern and, once in production, this undertaking would give employment to a much larger staff than they themselves employed.

THE GLASGOW foundry and engineering firm of G. & J. Weir, Limited, Cathcart, have received a valuable contract to provide sea-water distillation plant for the Persian Gulf oil state of Kuwait, which will be capable of providing a million galls. of fresh water per day. The order has been placed by the London consulting engineers, Ewbank & Partners, Limited, on behalf of the Sheik of Kuwait and installation of the plant is part of the programme of modernizing the public facilities in the State. This is one of the largest orders received in the West of Scotland this year and work at the Cathcart works will begin immediately, delivery being scheduled to start in mid-1954 and to be completed by the end of 1955.

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Raw Material Markets

Iron and Steel

The foundry industry generally is well employed at the present time, but prospects are less favourable. This applies particularly to foundries producing castings for household goods—washing machines, cookers, refrigerators, cisterns, and the like—in which there is now less activity for both home and export. The domestic trade is being hit by hire-purchase restrictions at home and by the closing of certain oversea markets. Many foundries thus affected are, however, so far able to offset the decline in their normal trade by undertaking work in connection with rearmament. The engineering and speciality foundries continue to be busily engaged, although they, too, are experiencing a falling-off in forward bookings. But they have plenty of business on hand at the present time; shortage of both pig-iron and scrap has, over a long period, precluded them from keeping abreast of their commitments, with the result that they still have arrears of orders.

The blast furnaces maintain consistent outputs, which are facilitated by adequate supplies of ore and improved deliveries of coke. The accent remains on the supply of basic pig-iron for the Steelworks; the shortage of scrap will necessitate a continuance of this for some time. There is no sign of improvement in imports of scrap and reliance for supplies is thus mainly on arisings from home sources, which are on a fluctuating scale. Deliveries of the low- and medium-phosphorus irons remain inadequate for the engineering and speciality foundries, while additional quantities of hematite and refined irons could be utilized. High-phosphorus pig-iron for the textile, light, and jobbing foundries is not available in excess of requirements, and production has recently been reduced by a furnace in the Derbyshire area being closed down for repairs. Another furnace will shortly be shut down for relining.

The re-rollers rely mainly on home consumers for orders for small sections and bars, export business having practically dried up on account of the severe competition from Continental and Japanese makers, whose prices are £8 to £9 per ton less than British figures. Arrears of orders and current business, however, enable re-rollers to record good outputs. Improved supplies of steel semis have been forthcoming from abroad and many of their former production difficulties have now been removed. Home requirements of re-rollers' products remain heavy, but a resuscitation of export trade would be welcomed so long as deliveries of steel could be maintained at least at present levels.

Sheet re-rollers are very busy on both home and export orders; they have also benefited by larger deliveries of sheet bars from oversea. Home steelworks readily dispose of all arisings of defectives, crops, etc.

Non-ferrous Metals

Now that the Government, through the Ministry of Materials, has stated its intentions regarding the disposal of lead stocks, there is less disposition to talk lead down to perhaps the £100 level when the market reopens on October 1. On the contrary, people are now more inclined, although foreseeing a figure below £131, to stress the fact that in the United States the price is steady at 16 cents (£128) and to point out that London and New York can hardly fail to have some influence on each other. In the Ministry statement about lead stocks no tonnage was mentioned, but it was made clear that only sufficient metal would be released to satisfy the demands of the Metal Exchange and of the consumers. Moreover, it was stated that the Ministry reserved the right to withdraw from the market when it judged that sufficient metal was coming forward to meet all requirements in the country, both on and off the Metal Exchange. This policy must almost certainly mean that only a portion of the Government's large holding of lead will be liquidated, and presumably the balance will be held as a kind of strategic stockpile. The main thing is that there is no question of a big tonnage of lead being thrown on to the market. At one stage it was felt in some directions that there was a risk of this happening, but all fears are now removed. Since it is generally accepted that events in lead may be taken as a forecast of what is likely to happen in zinc when, as is confidently anticipated, this metal also is freed, it may be presumed that the Government's stock, which is very considerable, will be dealt with in a similar manner to lead.

Actually, the zinc situation is not such as to inspire confidence, for the statistical position in the United States has deteriorated during the past few months, just as it has here. The smelters in the U.S.A. are carrying big stocks and consumption has shown a marked decline. The rise of ½ cent in the price, noticed in last week's report appeared to have been rather ill-advised, for consumers showed no enthusiasm in following the advance and the same applied to users here. At the end of last week the price position reverted to its previous level in the U.S., and on Sunday a similar move was announced here.

It was reported last week that the tin mines in Bolivia are to be nationalized, presumably in an attempt to obtain a lucrative price for the metal. Sales of tin this year have been relatively poor owing to the failure to agree a price with the American Reconstruction Finance Corporation so that there is a good deal of leeway to make up.

Official tin prices on the London Metal Exchange were:—

Cash—Thursday, £960 10s. to £961; Friday, £960 10s. to £961; Monday, £960 to £961; Tuesday, £956 to £956 10s.; Wednesday, £956 10s. to £957 10s.

Three Months—Thursday, £951 to £953; Friday, £951 10s. to £952; Monday, £949 10s. to £950 10s.; Tuesday, £946 to £946 10s.; Wednesday, £947 to £948.

Irish Foundry Conditions

During the hearing at Eire Labour Court last week of an application for wage increases by 300 workers in Hammond Lane and other metal firms their union secretary said they were resolute about not returning to a 48-hr. week working.

They claimed on July 10 an increase of 12s. 6d. a week, but the employers refused to consider any increase unless the Court recommended it. He further asserted that the Hammond Lane foundry group of companies paid their operators less than the standard paid to similar classes of workers in Dublin, although the official cost-of-living index showed an increase of 19 points. On the latter basis a weekly wages increase of 19s. should be paid. For the employers, Mr. D. D. Frame, for the Hammond Lane group, denied that the group did not pay wages comparable with those paid by other firms. Wages in Eire were much higher than in Great Britain. He agreed the workers were entitled to some increase, but the difficulty was that the group had very great competition both from English and Eire foundry firms. The group had discussed with the union the question of working an extra four hours weekly, thus giving them the increase they sought, but the union would not agree to the proposal. The Court adjourned.

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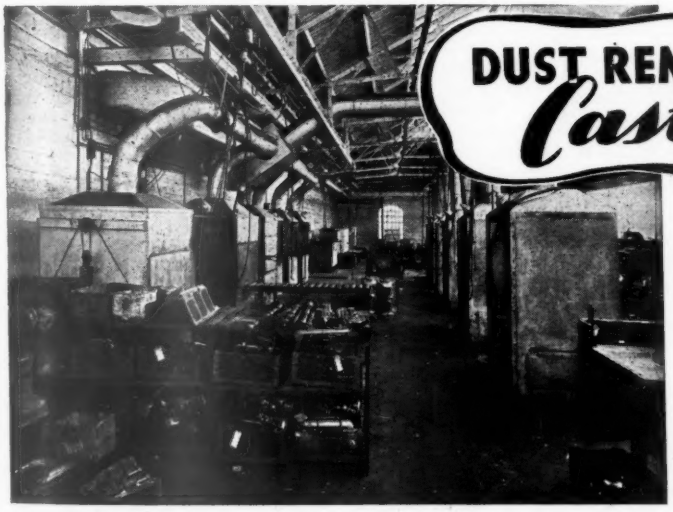

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered, unless otherwise stated)

September 24, 1952

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £13 1s. 6d.; Birmingham, £12 15s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £13 17s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. S), d/d within 60 miles of Stafford, £15 5s. 9d.

Scotch Iron.—No. 3 foundry, £14 4s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £17 4s. 6d.; South Zone, £17 7s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £17 14s. 6d.; South Zone, £17 17s.

Cold Blast.—South Staffs, £18 2s.

Hematite.—Si up to 2½ per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. Coast and N.-W. Coast of England, £13 11s. 6d.; Scotland (Scotch iron), £13 18s.; Sheffield, £14 12s. 6d.; Birmingham, £14 19s.; Wales (Welsh iron), £13 18s.

Basic Pig-iron.—£12 10s. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

Ferro-silicon (6-ton lots).—40/55 per cent., £57 10s., basis 45% Si, scale 21s. 6d. per unit; 70/84 per cent., £86, basis 75% Si, scale 23s. per unit.

Ferro-vanadium.—50/60 per cent., 22s. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £204; ditto, copper-free, £212.

Ferro-tungsten.—80/85 per cent., 28s. 7d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 31s. 7d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s., basis 60% Cr, scale 28s. 3d. per unit; 6/8 per cent. C, £80 17s., basis 60% Cr, scale 26s. 9d. per unit; max. 2 per cent. C, 2s. per lb. Cr; max. 1 per cent. C, 2s. 2½d. per lb. Cr; max. 0.15 per cent. C, 2s. 3½d. per lb. Cr; max. 0.10 per cent. C, 2s. 3¾d. per lb. Cr.: max. 0.06 per cent. C, 2s. 4d. per lb. Cr.

Cobalt.—98/99 per cent., 20s. per lb.

Metallic Chromium.—98/99 per cent., 6s. 5d. to 6s. 9d. per lb.

Ferro-manganese (blast-furnace). — 78 per cent., £43 15s. 2d.

Metallic Manganese.—93/95 per cent., carbon-free, £262 per ton.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 4s. 6d.; tested, 0.08 to 0.25 per cent. C (100-ton lots), £25 14s. 6d.; hard (0.42 to 0.60 per cent. C), £27 12s.; silico-manganese, £33 8s.; free-cutting, £28 8s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £31 9s.; case-hardening, £31 17s.; silico-manganese, £34 9s. 6d.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 8s.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 8s.; acid, up to 0.25 per cent. C, £31 17s.

Sheet and Tinplate Bars.—£25 3s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £29 14s.; boiler plates (N.-E. Coast), £31 1s. 6d.; chequer plates (N.-E. Coast), £31 3s.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £27 17s.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 15s. 6d.; flats, 5 in. wide and under, £31 15s. 6d.; hoop and strip, £32 10s. 6d.; black sheets, 17/20 g., £41 12s. 6d.; galvanized corrugated sheets, 24 g., £53 6s. 6d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £50 18s. 3d.; nickel-chrome, £71 7s. 9d.; nickel-chrome-molybdenum, £79 2s. 6d.

Tinplates.—57s. 1½d. per basis box.

NON-FERROUS METALS

Copper.—Electrolytic, £285; high-grade fire-refined, £284 10s.; fire-refined of not less than 99.7 per cent., £284; ditto, 99.2 per cent., £283 10s.; black hot-rolled wire rods, £294 12s. 6d.

Tin.—Cash, £956 10s. to £957 10s.; three months, £947 to £948; settlement, £957.

Zinc.—G.O.B. (foreign) (duty paid), £122; ditto (domestic), £122; "Prime Western," £122; electrolytic, £126; not less than 99.99 per cent., £128.

Lead.—Good soft pig-lead (foreign) (duty paid), £131; ditto (Empire and domestic), £131; "English," £132 10s.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £142 15s.; rolled zinc (boiler plates), all English destinations, £140 15s.; zinc oxide (Red Seal), d/d buyers' premises, — .

Other Metals.—Aluminium, ingots, £157; magnesium, ingots, 2s. 10½d. per lb.; antimony, English, 99 per cent., £225; quicksilver, ex warehouse, £64 10s. to £64 15s.; nickel, £454.

Brass.—Solid-drawn tubes, 27½d. per lb.; rods, drawn, 37½d.; sheets to 10 w.g., 31½d.; wire, 33d.; rolled metal, 30d.

Copper Tubes, etc.—Solid-drawn tubes, 32⅜d. per lb.; wire, 317s. 9d. per cwt. basis; 20 s.w.g., 346s. 3d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £205 to £218; BS. 1400—LG3—1 (86/7/5/2), £220 to £238; BS. 1400—G1—1 (88/10/2), £345 to £375; Admiralty GM (88/10/2), virgin quality, £375 to £380 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £355 to £385; L.P.Bl, £250 to £275 per ton.

Phosphor Bronze.—Strip, 44d. per lb.; sheets to 10 w.g., 46½d.; wire, 49½d.; rods, 44½d.; tubes, 42⅜d.; chill cast bars: solids 4s. 4d., cored 4s. 5d. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 2s. 9½d. per lb.(7%) to 3s. 10½d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 3½d. (7%) to 4s. 4½d. (30%); to 12 in. wide × .056, 3s. 3⅞d. to 4s. 4½d.; to 25 in. wide × .056, 3s. 5⅞d. to 4s. 6½d. Spoon and fork metal, unsheared, 3s. 0½d. to 4s. 1½d. Wire, 10g., in coils, 3s. 10d. (10%) to 4s. 10½d. (30%). Special quality turning rod, 10%, 3s. 9d.; 15%, 4s. 2d.; 18%, 4s. 6½d. All prices are net.